

MEMORIE
DELL'ACCADEMIA DELLE SCIENZE DI TORINO
Classe di Scienze Morali, Storiche e Filologiche
Serie V, Volume 42/1, 2018

An Easter Date Calendar in Ravenna

DI

EDOARDO DETOMA



ACCADEMIA DELLE SCIENZE DI TORINO

Memorie

della

Accademia delle Scienze di Torino

Classe di Scienze
Morali, Storiche e Filologiche

Serie V, Volume 42/1



ACCADEMIA DELLE SCIENZE DI TORINO
2018

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In copertina: calendario di date pasquali su lastra di marmo (Ravenna, Museo Arcivescovile, particolare).

ISSN: 1120-1622

ISBN: 978-88-9947-113-2

An Easter Date Calendar in Ravenna

Memoria di EDOARDO DETOMA* presentata dal Socio corrispondente
ALESSANDRO ROCCATI nell'adunanza del 9 maggio 2017
e approvata nell'adunanza del 7 novembre 2017

Riassunto. *Lo studio descrive il contenuto e la costruzione di un calendario di date pasquali attualmente conservato presso il Museo Arcivescovile di Ravenna in una stanza al primo piano del Museo. Il calendario nella sua forma attuale consiste in una lastra di marmo, in ottimo stato di conservazione, che misura circa 95 x 90 cm. Una guida turistica locale (G. Bustacchini, Ravenna: i mosaici, i monumenti e l'ambiente, Ravenna 1984) descrive brevemente l'oggetto come un calendario di date della Pasqua che «copre un periodo di 94 anni, dal 532 al 626», aggiungendo che «era costume, all'epoca, costruire il calendario delle date di Pasqua (che è una festività mobile) sulla base del calendario ebraico». Ambedue queste frasi sono solo parzialmente vere: infatti vi sono 5 cicli (anni) per settore, e 19 settori corrispondenti al ciclo di Metone, sicché il numero totale di anni descritti nel calendario è 95. Inoltre, al tempo in cui il calendario fu costruito, il Computus cristiano era sufficientemente avanzato da non richiedere riferimenti al calendario ebraico per la maggior parte, se non per tutti, i calcoli necessari.*

La tavola copre un periodo di 95 anni, apparentemente con inizio nell'AD 535 («Lunae primus»); però la prima data è l'AD 532 che corrisponde al primo ciclo del 17° settore (primo anno del ciclo di Metone). Dunque, le date si incrementano a partire dal 17° settore, primo ciclo (AD 532) al primo settore, primo ciclo (AD 535) continuando di seguito fino a completare un periodo di 95 anni.

Lo studio descrive l'evoluzione del Computus nei primi secoli dell'era cristiana e il contesto nel quale il calendario fu costruito, fornendo altresì la trascrizione e traduzione del testo delle date riportate che comprendono, oltre alla data della Pasqua, il numero del ciclo lunare, il numero del ciclo di Metone, la data del XIV Nisan (del mese lunare dunque, ovvero sia la data della luna piena), la data della Pasqua e l'età della Luna alla data della Pasqua.

Non sono stato in grado di trovare alcuna informazione relativa alla scoperta, luogo di origine e data di costruzione della tavola. Considerando il periodo coperto dalle date della Pasqua e l'uso del ciclo di 95 anni, si può ipotizzare un'origine nel VI secolo.

PAROLE CHIAVE: Calendari di Pasqua; Date pasquali; Museo Arcivescovile di Ravenna; Pasqua.

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Abstract. *The study describes the content and construction of a calendar of Easter dates currently stored at the Archiepiscopal Museum of Ravenna in a room on the first floor of the Museum. The calendar in its current form consists of a marble slab, in excellent condition, which measures approximately 95 x 90 cm. A local tourist guide briefly describes the object as a calendar of Easter dates that «covers a period of 94 years, from 532 to 626», adding that «it was customary, at the time, to build the calendar of Easter dates (which is a movable holiday) based on the hebrew calendar» (G. Bustacchini, Ravenna: i mosaici, i monumenti e l'ambiente, Guida storicoartistica, ed. Salbaroli, Ravenna 1984).*

Both these sentences are only partially true: in fact there are 5 cycles (years) per sector, and 19 sectors corresponding to the Metone cycle, so that the total number of years described in the calendar is 95. Furthermore, at the time when the calendar it was built, the Computus Cristiano was sufficiently advanced not to require redeployment to the Hebrew calendar for most, if not all, the necessary calculations.

The table covers a period of 95 years, apparently beginning in AD 535 («Lunae primus»); but the first date is AD 532 which corresponds to the first cycle of the 17th sector (first year of the Metone cycle). Therefore, the dates increase starting from the 17th sector, the first cycle (AD 532) to the first sector, the first cycle (AD 535) continuing to follow up to complete a period of 95 years.

The study describes the evolution of the Computus in the early centuries of the Christian era and the context in which the calendar was constructed, also providing the transcription and translation of the text of the dates reported which include, in addition to the date of Easter, the number of the lunar cycle, the number of the cycle of Meton, the date of the XIV Nisan (of the lunar month therefore, ie the date of the full moon), the date of Easter and the age of the Moon on the date of Easter.

I was not able to find any information about the discovery, place of origin and date of construction of the table. Considering the period covered by the dates of Easter and the use of the 95-year cycle, we can hypothesize an origin in the sixth century.

KEYWORDS: Archiepiscopal Museum of Ravenna; Calendar; Easter; Computus.

Introduction

Location

The calendar in its present form is an extremely well preserved slab of marble about 95 cm x 90 cm in size; it is located in a room on the first floor of the Archiepiscopal Museum in Ravenna, Italy. A local tourist guide (ref. [R1]) briefly describes the object as a marble slab inscribed with 19 sectors; recognizes the object as a Paschal calendar «covering a period of 94 years, from the 532 to the 626», adding that «it was custom, at that time, to construct the Paschal calendar (that is a mobile Holiday) by recalling the Hebrew calendar».

Both these sentences are only partially true: as we will see, there are 5 cycles (years) per sector, so that the total number of years covered is 95. Regarding the last sentence, the Christian Computus had progressed far enough that, at the time in which the slab was inscribed, it could free itself from references to the Hebrew calendar for most if not all of the computations involved.

The table covers a 95-year cycle, apparently starting from 535 AD («Lunae primus»); however the earliest date is 532 AD corresponding to the first cycle of the 17th sector (first year of Metonic cycle). Therefore, the dates progress from the 17th sector, first cycle (532 AD) to the first sector, first cycle (535 AD), continuing around to the 16th sector, first cycle (550 AD), to the 17th sector, second cycle (551 AD) and so on.

I have been unable so far to find any information regarding the discovery, original location and the date in which the table was inscribed. Considering the span covered by the Easter dates and the use of the 95-year cycle, a VI century origin can be inferred, but this is no more than an educated guess.

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SOME ABBREVIATIONS USED IN THE EPIGRAPHIC TEXT

$\overline{AP}$, $\overline{APR}$	for <i>Aprilis</i> , April
$\overline{\zeta}$	for digamma
$\overline{CY}$	<i>Cyclus</i>
$\overline{L}$, $\overline{LV}$	<i>Luna(e)</i>
$\overline{MI}$	for <i>MAI</i> , <i>Maius</i> (in the text, transliterated with <i>MAI</i>), May
$\overline{PA}$, $\overline{PAS}$	<i>Pascha</i>
$\overline{PR}$	<i>Pridie</i>

Historical background

Dates related to the Passion of Christ: Passover and Nisan XIII

The computation of Easter was the main technical problem facing the Christian Church during its first centuries. The Passion of Christ occurred on a particular day of the first month of the Hebrew Calendar, Nisan. The

particular day was Passover that is celebrated on the 14th day of the month of Nisan, therefore at full Moon.

To be the first month of the year, Nisan starts with the appearance of the thin crescent of the moon of the first lunation in spring. The lunar month is about 29.5 days in duration. Twelve lunar months average only 354 days. Since the lunar calendar is falling short of 11 days with respect to the solar calendar, the Jews had to intercalate lunar months to keep the lunar months aligned with the sun. Moreover, since a month must be made up of an integer number of days, lunar reckoning alternates months of 30 days (full) with months of only 29 days (hollow).

Quartodecimans: Passion or Resurrection

Early Christians, especially those living in Syria and Asia Minor, celebrated Easter on the 14th day of Nisan. They were called Quartodecimans for this reason. Other Churches, especially in Egypt and in the West, insisted that Easter be celebrated instead on the day of the Resurrection, the Sunday after Nisan. And since, on the year of the Passion, Passover occurred on Saturday (Sabbath), the result was that Sunday became the day of the Resurrection and the Church position shifted to celebrate Easter on the first Sunday immediately following Nisan XIII, i.e. the 14th days of the lunar months or the first full Moon after the spring equinox.

Obviously, the two positions had theological implications: the Quartodecimans, celebrating on the Jewish Passover, thought the Christ was the true Paschal lamb slaughtered to free the people of God from the sin¹. For the group advocating a Sunday celebration, Easter was the anniversary of the resurrection and the first day of a new age. This will be also reflected in numbering the days of the week, so the convention was adopted that Sunday = 1, the first day of the week, and Saturday (= 7) the last.

Finally, the Quartodecimans position was officially rejected, but a subtlety remained to be solved: if Nisan XIII fell on Sunday, was it permissible to celebrate Easter on that day? From the beginning of the III century, the position of the Roman Church was that it was not. If Easter commemorated the Resurrection and not the Passion it could not be celebrated until Nisan XVI, i.e.: the third day, inclusive. But many Christians were unwilling to abandon the links with Passover and therefore reluctant to accept this rule: for them Nisan XIII was still acceptable, or, since according the Synoptic

¹ See ref. [R2], page XXXV.

Gospels the Passion took place in reality on Nisan XV², this could be the earliest day for the Paschal celebration.

A second issue was raised on the question if Christians should follow the Jewish rules to determine the occurrence of Nisan XIII itself. Obviously the debate was much political and theological, the Christian communities wanting to free themselves from the Jewish heritage. But it will be unfair to classify this issue only on these grounds: in reality there were technical reasons to do so: first of all, some claimed that the Jews did not observe the equinox to determine Nisan, and in doing that the Jewish Computus could be in error. Moreover, in times in which communications were difficult, the Christian Church could not rely on another faith to determine the date of the most important solemnity in the Christian liturgical calendar.

First Easter tables

	Alexandrian Church	Roman Church
Equinox	21 March terminus a quo for Nisan XIII	25 March terminus a quo for Easter
Lunar limits for Easter Sunday	XV-XXI	XVI-XXII
Calendar limits for Easter Sunday	22 March-26 April ³	23 March-21 April ⁴

Table I. Paschal dates correspondence for the Alexandrian and Roman Churches.

In Egypt, the approach was pragmatic, and the first known Easter table based on the astronomical determination of the equinox on March 21 was published by Dionysus, bishop of Alexandria, between 257 and 265 AD. In the West, the approach was equally sound but certainly less pragmatic. Hippolytus of Rome devised a Paschal table in 222 based on the assumption that the earliest date for Nisan XIII was on March 18, the day in which the Sun enters the constellation of Aries in the old Julian calendar, and hence

² The debate on which Passover date Christ celebrated the last supper is not easy to resolve. See ref. [R3].

³ The latter date is one full lunar month after the former, plus 7 days to accommodate the following Sunday, for if Nisan XV fell on March 21, that whole lunation has to be disregarded and only the following lunation will count as the first one of spring.

⁴ 21 April is clearly insufficient to accommodate the second lunation, but was necessary to avoid superimposing the Paschal celebration with the festivities of the foundation of Rome, starting on April 21.

the astronomical beginning of spring. In this event, the earliest possible date for the beginning of Nisan was March 5.

This position raised a considerable controversy and debate, since an effort was launched to justify the choice more on theological grounds than on astronomical reasons. Neglecting the amusing arguments, that the interested reader can find in ref. [R2], page XXXVII, Dionysus of Alexandria issued his new 8-year Easter table accompanied by a Paschal letter stating that it was not licit to celebrate Easter before the equinox.

These were the rules that, after much prior debate, were set forth in the Council of Nicea; actually only one new rule was introduced, and that is that Easter could not be celebrated on Nisan XIII, even if it fell on Sunday. The Alexandrian church interpreted the limit to mean that if Nisan XIII fell on Sunday, the celebration of Easter should be postponed to the next Sunday, in other words the lunar limits (age of the Moon) were actually XV-XXI. The Romans instead held to the limits of XVI-XXII, but in practice allowed the celebration on the XV⁵.

Limits for the occurrence of the equinox

Additional confusion was related to the limits as set by the occurrence of the equinox. For the Romans, thinking in terms of their solar calendar, the equinox was the early limit (*terminus a quo*) for Easter itself. For the Alexandrians, reasoning in terms of the Jewish lunar calendar, the equinox was the early limit of Nisan XIII and not of Easter. Another point of contention was the date of the equinox: the Alexandrian Church, basing its position on the astronomical tables of Ptolemy, named it correctly as 21 March. Most Romans instead thought that the equinox fell on 25 March, the day Julius Caesar had marked in their calendar. The situation, rather confusing, is summarized in Table I.

Sometime during the IV century, Rome abandoned the equinox on 25 March, moving to 21 March, but still refused to change the upper limit.

Alexandrian rules

Notwithstanding the controversy, historical records show that in the IV and V centuries Rome celebrated Easter according to the Alexandrian dates. In 395 AD, the bishop Theophilus of Alexandria tried to endorse a *de facto* situation by presenting a new Paschal table to the emperor Theodosius. The

⁵ See ref. [R2], page XXXVIII.

attached explanatory material (*quaestiones*) defined clearly the Alexandrian rules:

- the Bible dictates that Passover must be in the «month of first fruits», which means spring, which means after the equinox;
- therefore, Nisan XIII should never fall before 21 March;
- should Nisan XIII coincide with a Sunday, Easter must be postponed until the following week;
- Easter must sometimes be celebrated in the «second month», by which Teophilus means the second solar calendar month after the equinox (i.e.: after 22 April) rather than the second lunar month, questioning directly with this assumption the Roman upper limit.

The rules posed no simple task for the relevant computations that had to be devised in such a way to be simple enough that a simple priest could carry them to correctly compute the date of Easter.

Paschal tables and luni-solar cycles

The outcome of the controversy started shifting its weight from the initial theological arguments to the design of an authoritative and reliable Paschal table. And such a table would be based on a reliable luni-solar cycle. Now the difficulties shift from theological to astronomical grounds. The Julian calendar is a list of named solar days, but neither the lunation nor the solar year cover an integer number of days. The solar year is approximately a quarter-day longer than the calendar year and the excess accumulates to one full day over 4 years. This was already known to the Egyptians (even if they never adjusted the calendar to compensate for it, see the Canopus decree) and constitutes the basis for the Julian reform. In antiquity, and in the Middle Ages, the additional day was inserted on 24 February (the 6th day prior to the Calends of March): from this circumstance comes the designation *annus bissextus*, to indicate a year with two 6th days prior to the Calends of March. The lunar month is slightly in excess of 29.5 days, so lunar calendars devised the simple artifice to alternate⁶ months of 29 days («hollow») and 30 days («full»).

The fundamental problem in constructing a luni-solar cycle is that the solar year does not contain a whole number of lunations. The average duration of the true lunar months is 29.5306 days while the solar year measures 365.2422 days. Therefore, there are 12.3683 lunations in a solar year. Over three years, the fractional part 0.3683 amounts to slightly over

⁶ See, for instance, Geminus, *Elementa Astronomiae*, c. 8, in T. Heath, *Greek Astronomy*, page 136: «The exact length of the monthly period is, as we said, $29 \frac{1}{2} + \frac{1}{33}$ days, but in ordinary civil life is taken roughly as $29 \frac{1}{2}$ days, so that two months come to 59 days. For this reason the civic months are alternately reckoned as «full» (30 days) and «hollow» (29 days)».

one lunar month, so that about every three years an extra lunar month can be inserted, and the solar year will contain 13 lunations.

This can be explained also in another way. Because the Julian year is 365 days long and 12 lunar months of 29.5 days each total 354 days, the Moon is 11 days older at the end of a solar year than it is at the beginning. Therefore, the age of the Moon on any given calendar date will increase by 11 each year⁷. But since it cannot exceed 30 (the maximum length of the lunar month), when it does the computist subtracts 30 from the running total, and thereby intercalates an additional lunar month.

- The aim of the computist is to find a whole number of solar years containing a whole number of lunations so that a correspondence can be set between lunar and solar dates and this correspondence will repeat at the end of the cycle.

The task is, strictly speaking, impossible, because the two cycles are incommensurate and the excess fraction 0.3683... is an irrational number. But approximations have been found since the antiquity and the more common fractions are as follows⁸:

Fractional approximation	Approximation value to 0.3683...	Fractional approximation	Approximation value to 0.3683...
$\frac{3}{8}$	0.3750	$\frac{7}{19}$	0.3684
$\frac{4}{11}$	0.3636	$\frac{31}{84}$	0.3690

Table II. Rational approximations to the luni-solar cycle.

The best approximation is $\frac{7}{19}$, intercalating 7 lunar months over a cycle of 19-years, known also as the Metonic cycle. Other approximations, even if less accurate, conserve their appeal for simplicity. The first option is simply to intercalate 3 lunar months over a cycle of 8 years, the *octaëteris*⁹. Or 4 lunar

⁷ See Geminus, as above, page 138: «If then we reckon the months in the year according to the Moon, we shall fall behind by 11 $\frac{1}{4}$ days in comparison with the solar year».

⁸ See ref. [R2], page XLII.

⁹ See also Geminus, as above, page 138: «Accordingly, in each period of 8 years three intercalary months are reckoned, in order that the deficiency which arises in each year in comparison with the Sun may be made good, and so, when 8 years have passed from the beginning of the period, the festivals are again brought into accord with the seasons of the year».

months over 11 years (the *hendecas*). Or 31 lunar months over 84 years¹⁰. The above cycles are based on conventional, regularized lunar months and solar year, and all were used in antiquity, though the 19-year cycle is the most accurate¹¹.

Intercalated lunar months: embolisms

The interpolated lunar months are known as embolisms and they are always of 30 days (there is no hollow embolism), and a year containing 13 lunar months is designated as embolismic. But where to insert the extra lunation in an embolismic year without disrupting the alternation of full and hollow lunar months?

Every lunation «belonged» to a solar month, the month in which it ended: January's lunation was full, February's hollow, etc. Therefore, the ideal solution would be to make the embolism «invisible» by inserting it in a calendar month whose proper lunation ended on the first or second day. This would allow this second month to absorb its own lunation and the pattern to continue undisturbed. But, even if properly inserted, an embolism can throw off the calculation of Nisan XIII by a day.

«Saltus lunae»

Finally, the 19-year cycle, even if it is the more accurate than the others considered, still has an additional difficulty. Consider the composition of the 19-year cycle; we have¹²

(1) 114 full months, of 30 days each	= $114 \cdot 30$	3420.00 days
(2) 114 hollow months, of 29 days each	= $114 \cdot 29$	3306.00 days
(3) 7 embolismic months, of 30 days each	= $7 \cdot 30$	210.00 days
(4) $4\frac{3}{4}$ additional days for leap years	=	4.75 days
	TOTAL	6940.75 days

while 11 solar years total $365.25 \cdot 19 = 6939.75$ days. Therefore the lunar cycle exceeds the duration of 19 solar years by exactly one day. Hence, during the cycle, the lunar count must «jump» a day to align the two cycles; this is

¹⁰ Which has an additional advantage, in its correlation with the weekdays, that will be explained below.

¹¹ A correction to the Metonic cycle was applied by Callippus in the 76-year cycle, which follows the same arrangement for intercalary months than the Metonic cycle. See Geminus, as above, page 141.

¹² See ref. [R5], page 45.

the so-called *saltus lunae*, or leap day for the Moon¹³. Again, the positioning of the saltus was critical, since it changed the age of the Moon by a day, and was usually positioned in the 18th or 19th year of the cycle.

Correlation with the weekday

Every cycle examined so far can produce dates for the Easter full Moon, but yet cannot produce a true cycle of Easter dates, since the cycle has to accommodate a repeatable cycle of Sundays, i.e.: weekdays. To do so, the cycle has to be divisible by 28, the numbers of years in the weekday cycle (28 years = 255500 days are exactly divisible by 7 and 365.25). Only two cycles of the many considered offered this possibility:

- the 112-year cycle of Hyppolitus, which was a double cycle¹⁴ of *octaëteris* (8-year cycle), repeated four times (see ref. [R3]);
- and the 84-year cycle.

This was a major argument in their favor, but at the end could not compensate for the inaccuracies of their luni-solar reckoning and they were abandoned in favor of the 19-year cycle.

Final construction of the 19-year cycle

Before tackling the solution to the problem of correlating the luni-solar calendar with the weekday, let's complete the treatment of the 19-year cycle. Having decided in favor of the Metonic cycle because of its intrinsic accuracy, and having resolved the one day offset by introducing the *saltus lunae*, we are still facing the problem on where to locate the embolisms.

Consider Table II above; the 8-year cycle (*octaëteris*) yields an approximation of 0.3750 to the true fractional part of 0.3683, with a residual error of 0.0067; on the other hand, the 11-year cycle yields an approximation of 0.3636, with a residual error of – 0.0047. The sign and magnitude of the errors are such to cancel and in this property rests the superior accuracy of the combined 19-year Metonic cycle. Having selected the latter because of its accuracy, the idea will be to insert the embolisms by using the relative accuracy of the two sub-cycles of 8 and 11 years. This line of reasoning

¹³ See [R2], page XLII.

¹⁴ The eighth cycle repeated the first, so in reality the Hyppolitus cycle is seven 8-year cycles. As for the 84-year cycle, it has the advantage of being an integer number of solar cycles of 28 years (respectively 4 and 3 for the 112-year and 84-year cycles) so that the dates of Easter repeat also in terms of weekday (Sunday).

results in the following distribution of common (C) and embolismic (E) years in the 19-year cycle, divided into two sub-cycles, the *ogdoas* of 8 years and the *hendecadas*, the remaining 11 years¹⁵:

<i>ogdoas</i>	first 8 years	CCECCECE	3 embolisms inserted
<i>hendecadas</i>	remaining 11 years	CECCECCECE	7 embolisms inserted

The actual insertion of the embolisms was defined with the rationale outlined previously, i.e.: at the beginning of a solar month, not to disturb as far as possible the sequence of full and hollow lunar months associated to the solar months¹⁵:

year 3	2 December	
year 6	2 September	
year 8	6 March	(will affect the Paschal reckoning)
year 11	4 December	
year 14	2 November	
year 17	2 August	
year 19	5 March	(will affect the Paschal reckoning)

The table of Anatolius, bishop of Laodicea, composed in 258, is the first recorded Paschal table based on the Metonic cycle. The success of his table, which has been lost and is known¹⁶ to us through Eusebius' *Historia ecclesiastica*, was reinforced by the fact that the expertise was available at Alexandria to construct new 19-year tables when the old ones expired.

The Easter table of Theophilus contained an additional column, filled with numbers from 1 to 7, standing for the weekday from Sunday to Saturday, and representing the weekday on 24 March of the year in question¹⁷. This paved the way to a full Paschal cycle, where the 19-year cycle could be repeated 28 times after which also the weekday column will repeat, covering a total span of 532 years.

But this did not happen so soon. In the West, the Roman 84-year tables were still entrenched¹⁸. Alexandrian tables were difficult to adopt in the West, since they were based on the Egyptian calendar, which began in September and inserted its leap day in August. Moreover, the Egyptian months did not

¹⁵ See ref. [R2], page XLVI.

¹⁶ Or in Rufinus's «De ratione paschali».

¹⁷ See ref. [R2], page XLVII.

¹⁸ The advantage of the 84 year cycle is in that it repeated the days of the week.

coincide with the Roman ones. To gain acceptance in the West, the 19-year Paschal tables had to be modified for users of the Julian calendar.

The appearance of a 95-year cycle

The first table to attempt so ascribed¹⁹ to bishop Cyril of Alexandria, nephew and successor of Theophilus. Its importance in connection with the calendar in Ravenna is that the pseudo-Cyrrillan table covered 95 years (AD 437-531) or five 19-year cycles, which is exactly the time span (but with different limits) covered by the table in Ravenna. This was the first time that the Alexandrian system was laid over a Julian calendar, with the year beginning on 1 January, its leap year intercalary day inserted on 24 February and its specific grid of months.

The pseudo-Cyrrillan table comprised eight columns²⁰: the number of years as reckoned from the beginning of the reign of Diocletian, the indiction, the lunar epact for 22 March, the concurrent, or weekday, on 24 March, the year of the lunar cycle, i.e.: a 19-year cycle beginning in the year when the Moon is one day old on 1 January, the Julian date of XIII Nisan, the Julian date of Easter and, finally, the age of the Moon on Easter Sunday. The correspondence between the information contained in the pseudo-Cyrrillan table, the Ravenna table and the Bede's table is shown in Table III.

Since both the Teophilus tables as well as the ps.-Cyril table are both lost, the Ravenna table may be the only remaining link to the 95-year cycle introduced at the beginning of the V century.

In the face of the challenge posed by the Alexandrian tables, the supporters of the 84-year cycle started adjusting their tables to correct for the lunar anomaly. Unfortunately, the Alexandrian tables were not perfect either, simply because they allowed to cyclically repeating the Easter full Moon but not Easter itself. This left room to a multiplicity of solutions²¹, where cycles were shifted to align the start of the Paschal cycle to dates of theological or computistic significance, such as the year of the Exodus or the year of Christ's Passion.

Rome did not take a definite position, except with regard to the upper limit of 21 April. However, when this occurred, namely in AD 444 and 455, Rome aligned his Easter date to the Alexandrian Computus, disregarding

¹⁹ The authorship of the table is a subject of debate. In the following I will refer to this table as «pseudo-Cyrrillan table» following ref. [R2].

²⁰ See ref. [R2], pages XLVIII-XLIX.

²¹ See ref. [R2], pages XLIX-L.

doctrine in favor of reason²². In AD 444 Bishop Paschasinus of Lilybaeum responded to Pope Leo's request for advice formally endorsing the Alexandrian solution in the form of the ps.-Cyrillan tables. Again, in AD 455 Leo resorted to the Emperor Marcian to resolve the crisis; the Emperor referred the matter to Proterius, bishop of Alexandria, who defended again the superiority of the Alexandrian system.

Information in the pseudo-Cyryllan table (five 19-year cycles)	Information in the Ravenna table (five 19-year cycles)	Information in the Bede's tables (twenty-eight 19-year cycles)
The number of years as reckoned from the beginning of the reign of Diocletian	The absolute datation is missing in the table in Ravenna, but absolute dates can be derived from the position of Easter within the 532-year cycle of the Bede's table	Anno Domini
The indiction	Missing in Ravenna	Present
The lunar epact for 22 March	Missing in Ravenna	Present
The concurrent, or weekday, on 24 March	Missing in Ravenna	Present
The year of the lunar cycle, i.e.: a 19-year cycle beginning in the year when the Moon is one day old on 1 January	The Ravenna table is ordered by the lunar cycle	Present, however the Bede's tables are ordered by the Paschal 19-year cycle, starting with Lunar epact zero on 22 March
The Julian date of XIII Nisan	Present, only one per sector, common to 5 years of the same lunar cycle	Present
The Julian date of Easter	Present	Present
The age of the Moon on Easter Sunday.	Present	Present

Table III. Correspondence between the pseudo-Cyryllan table, the Ravenna table and the Bede's table.

The contribution of Victorius of Aquitaine

Leo gave in again, but to avoid further embarrassments Leo's archdeacon Hilarius commissioned Victorius of Aquitaine to investigate the discrepancies between the Roman and Alexandrian system and to find ways to avoid them. In AD 457 Victorius issued new tables, abandoning the old 84-year cycle in favor of the 19-year cycle, which Victorius knew in the form of Teophilus and ps.-Cyril tables. Victorius also dismissed without comments the sacrosanct 21 April limit.

²² See ref. [R2], page L.

For the first time²³, his table dated years according to *Annus Passionis*, assumed to coincide with *Annus Mundi* 5229 according to the reckoning of Eusebius, as translated by Jerome, or AD 28. The chronology was reinforced by a list of consuls down to AD 457.

His postulates are the following²⁴:

- that the vernal equinox occurs on 21 March, in agreement with the ruling of the Nicea Council;
- that the 19-year cycle represents a good model for the luni-solar motion;
- that the age of the world can be derived from the Ancient Testament chronology, as shown by Eusebius and later on by Saint Jerome and Prosperus of Aquitaine.

Assuming that the world was created in *Annus Mundi* 1, on Sunday 25 March, the full Moon would have been created on 28/29 March, Victorius states that it is not necessary to revise these dates by adopting the Alexandrian date for the equinox. Starting from this assumption, from the Biblical chronology it is known that Christ's Passion occurred in *Annus Mundi* 5229, in the year²⁵ of the consulate of the two Geminus (AD 28).

- Dividing 5229 by 19 and taking the remainder, we find that Christ was crucified the fourth year of a 19-year Metonic cycle that starts with the Creation, and the crucifixion on Nisan XIII occurred on 26 March.

Having defined this date, Victorius proceeded to compute the Easter dates for the next 430 years to get to the current year (AD 457). But, proceeding with the computations to cover future years he quickly discovered²⁶ that the Easter dates started repeating with regularity after another 102 years ($430 + 102 = 532$ years).

²³ See ref. [R2], page LI.

²⁴ See ref. [R3].

²⁵ I have a possible discrepancy here, that I would like to note; an authoritative source as the Bickerman (ref. [R4], page 154) lists as 29 AD the year of consulate of C. Fufius Geminus and L. Rubellius Geminus. The reason for this apparent discrepancy was not known to me. However, Dr. Nothaft pointed out that this discrepancy in Victorius' dating the Gemini-consulate is easily explained by his reliance on the chronicle of Prosper of Aquitaine, which also wrongly dates the Gemini to the year we call AD 28, because it is based on a faulty consular list.

²⁶ As Dr. Nothaft pointed out to me, in the East the 532-year cycle was already known and probably discovered by Annianus; the work of Annianus was only known late in the West, mainly based on the Chronicle of Georgios Synkellos. However, it is difficult to assess if Victorius knew of the work of Annianus.

patrefacere properavi, quae summa ita cunctarum, quibus exempta est, serie regularum sua revolutione conplectitur, ut eodem tramite et in id, unde est orta, revocetur et ad finem pristinum denuo circumacta perveniat²⁷.

The only real advance with respect to the ps.-Cyril tables, Victorius projected his table for 532 years, therefore effectively linking the 28 years solar cycle (and the relevant weekdays necessary to the computation of the Easter's Sunday) to the 19-year luni-solar cycle, and he knew that his table would repeat after these years.

- Incredibly as it may appear, he failed to understand why, since he reckoned 532 years as 4×133 years instead of 19-year of the Metonic cycle $\times$ 28 years of the solar cycle, as Dionysus Exiguus and Bede did.

Unfortunately, his table was not well accepted by either Alexandrians and Romans; having placed the first year of his lunar cycle in the fourth year of the 19-year Alexandrian cycle, Victorius was obliged to force the *saltus lunae* (in the 19th year of the Alexandrian cycle) in the 16th year of his own cycle, and from here to repeat the saltus cyclically after 19 years²⁸. Moreover, the *saltus* occurred in the 19th year of the Alexandrian cycle, which was related to the Era of Diocletian (AD 284) but not to the *Annus Mundi*. The consequence was that the Easter dates according Victorius showed one day of difference in 13 of the 19 years of the cycle (years 7th to 19th).

Oddly enough, Victorius placed the earliest beginning of Nisan at 5 March, and Nisan XIII as early as March 18, whereas the Alexandrians placed the earliest beginning of Nisan at 8 March to avoid having Nisan XIII prior to the spring equinox. Finally, he clung to the old Roman limits of XVI-XXII instead than switching to the Alexandrian limits of XV-XXI (see Table I above).

Notwithstanding these oddities, Victorius was not able to keep the Easter date within the traditional limit set by the Roman Church: in the 37th year of his cycle Easter fell on 22 April, in the 48th year fell on 23 April and so on. These facts impacted the adoption of his new cycle that was unable to replace the traditional methods or the new tables of ps.-Cyril, tables that were in use up to the end of the V century.

It is important to note here, however, that the Ravenna table is ordered on the 4-year shifted²⁹ lunar cycle; the origin of this cycle is sometimes debated,

²⁷ See ref. [R5], page 48.

²⁸ See ref. [R5], page 49.

²⁹ With respect to the Metonic cycle.

and also in ref. [R2] the commentator refers, when Bede's introduced this cycle in his own tables, to some cycle related to Roman lunar year reckoning while admitting that his true origin remains obscure:

The lunar cycle in column 5 must have been something of a puzzle to Bede, as it plays no role at all in the computation of Easter. It replicates the structure of the 19-year cycle, but begins in year 3 of the 19-year cycle, when the Moon is new on 1 January. Because of this 1 January epact, Bede took a guess that it was a Roman lunar cycle. This is not the case, but its true origin remains obscure. It arrived in the West with the ps.-Cyrillan Paschal table, and it was obviously meant to serve as a concordance to some other form of reckoning. Based on his guess, Bede therefore created a table patterned after the one Dionysius made for the 19-year cycle. The lunar cycle does have one use, however; it makes it easy to locate the age of the Moon on 1 January (ch. 57)³⁰.

The work of Dionysius Exiguus

The archdeacon Hilarius, shortly after commissioning the tables, became Pope himself, and so found himself in the unpleasant position to be supporting a work that himself had commissioned but was plagued by flaws and needed a revision. Therefore, he asked Victor of Capua to write a critique of the work of Victor of Aquitaine and call for new tables.

Dionysius Exiguus, a monk of Scythian origin³¹ resident in Rome, thought that the best solution was to scrap them in favor of full Alexandrian tables. He translated the ps.-Cyril table of 95 years in Latin, constructed a continuation³² for another 95 years (AD 532-627), attached a prologue and a translation of the Alexandrian computistic rules and sent it to an unidentified bishop named Petronius. The work of Dionysius attracted little attention at the beginning.

In AD 525 Dionysius addressed a letter to Bonifatius and Bonus, *primicerii* of Pope John I, to explain a serious discrepancy between the Alexandrian and Roman Computus that would have occurred the next year (AD 526)

³⁰ See ref. [R2.], page 346.

³¹ Cassiodorus in «De Institutione Divinarum Litterarum», ch. 23: «Fuit enim nostris temporibus et Dionysius monachus, Schytha natione, sed moribus omnino Romanus, in utraque lingua valde doctissimus: reddens actionibus suis quam in libris Domini legerat aequitatem».

³² This covers, except for the 4 years shift already noted between the lunar 19-year cycle of Victorius and the Paschal cycle, the same time span as the Ravenna tables.

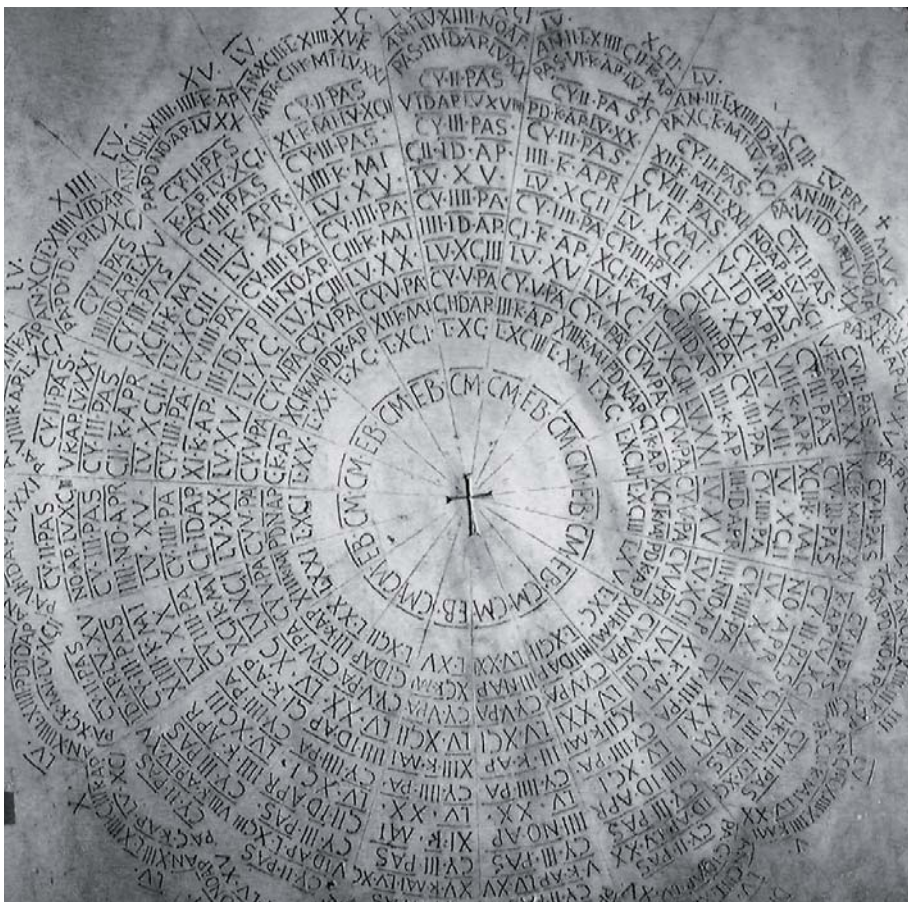


Figure 1. The Paschal calendar in Ravenna.

because of the misplacement of the *saltus* in Victorius's tables. Dionysius outlined the proper Alexandrian sequence of common and embolismic years and Bonifatius brought the matter to the attention of the Pope himself. The Pope's sudden death prevented a quick endorsement of the Dionysius's tables, which had only marginal prestige in comparison with Victorius's «orthodox» and «papally-sanctioned» tables.

Some points of the Dionysian tables are worth noting for their relationship with the Bede's tables. The old 84-year Roman cycle was based on the age of the Moon (Epact) on 1 January. The Alexandrian Epacts, on the other

hand, began on 1 September, the Egyptian New Year. Dionysius referred the Epacts on 22 March, because it marks the earliest possible date for Easter. This will be included in Paschal tables from now on, and it is still the framework for the Computus in the Bede's tables.

- The Dionysius cycle, therefore, starts in the year in which the Lunar Epact on 22 March is zero.
- The second novelty was to shift the origin of dates used in his table, from the Era of Passion (AD 28) to the Era of Incarnation, what is now known as *Anno Domini* (AD), which is the basis of time reckoning today in Christian (and non-Christian) countries.

This is the historical background in which the Ravenna calendar was designed and inscribed on the stone slab that has survived until today.

Commentary and translation

Time span covered by the table

Apparently, the sectors are ordered in the lunar cycle³³ (starting with the age of the Moon, i.e.: the epact, equal to 1 on January 1st) and not in the Metonic cycle. The two are shifted 4 years with respect to each other, the cycle *Lunae primus* indicated in the table corresponding to the fourth year of the Metonic cycle. In the Julian calendar, the first year of the first cycle corresponds to the year AD 535. However, progressing through the table, we find that, when the first Metonic cycle completes on the first year of the *Lunae XVI* sector (550 AD), the next sector (*Lunae XVII*) reports the Easter date on the first year of the Metonic cycle corresponding to AD 532.

Therefore, the dates progress from the *Lunae XVII* sector, first cycle, first year of the Metonic cycle (AD 532), that is the first date of the table, to the *Lunae XVI* sector (550 AD), after which the next date can be found on the second cycle, *Lunae XVII* sector, where the Easter date for AD 551 can be found.

Even if ordered by lunar cycle, the calendar closely matches the 532 Paschal cycle reported in the Bede's tables, and therefore reference will be made to these tables, even if produced somewhat later, to explain the underlying structure of the calendar itself.

³³ See ref. [C1], page 97: «Initio statim Cycli Ravennatis legimus: Anno Primo, Luna XIV. Nonis Aprilis: Pascha III Idus Aprilis, Luna XX, eodemque modo sub eodem anno Lunae XIV. ac Paschata ab iisdem indicata, recitantur».

Structure of the calendar

The Latin epigraphy has been trans-littered and translated in the following pages, starting from the first sector to the end. Each sector reports five years, starting from the first year of the first sector (*Lunae «primus»*)³⁴ which corresponds to the year 535 AD in Bede's Tables.

The commonality of the five years in each sector is in the fact that they share the date of the 14th Moon, i.e.: XIII Nisan, on the same day. This is clearly stated in the first sentence for the first year (cycle) in each sector, which addresses the date of the 14th Moon (*Lunae XIII*), and is not repeated for each of the following four cycles.

For each Easter date that follows, the table declares the date of occurrence and the age of the Moon on the Easter day. This makes easy to check for errors: since the date of the XIII Moon is known for each sector, and Easter follows always the XIII Nisan, then the difference between the Easter date and the Full Moon date (XIII Moon) added to 14 will give the age of the Moon on the Easter day. Example: «Sector 1, first cycle. The Moon XIII is on April 2, and its age is 14. Next, Easter is stated to occur on April 8, six days later. Therefore, the age of the Moon at Easter is 14 + 6, or 20».

The sequence of years goes round through the table. Starting from the first year (*Lunae Primus*, cyclus P³⁵), the Easter for the second year will be reported in the second sector, first cycle, and so on, until the 19th sector, first cycle is reached. Then the calendar continues with the first sector, second cycle, and so on, until the end is reached with the 19th sector, fifth cycle.

Epigraphy

One peculiar fact in the calendar is the use³⁶ of the archaic Greek stigma (digamma) Ϛ to represent³⁷ the number 6³⁸. This is not fully

³⁴ In ref. [C1] it is referred as «Lunaris primus» (Caput IV, page 83), since «quam vetusti computistae Lunarem appellabant»; I have used the genitive (*Lunae*) referred to cycle for simplicity.

³⁵ The first cycle is always implicit in the table.

³⁶ For the use of Greek letters, and in particular stigma, in Christian early epigraphy, see P. Testini, *Archeologia Cristiana*, Rome 1958, pages 358 and 399-400 (referred to me courtesy of Paola Marone).

³⁷ This has been already noted by early writers. See ref. [C4], footnote at page 286: «Numerus VI, non his binis numeralibus Romanorum notis, sed hic, & persaepe ob laterculi angustias exprimitur caractere G inferius tamen sinuato, ut videre quisque potest in adiecta Tabula XVI».

³⁸ Curiously this has been noted not only by early scholars, but also by past visitors. W. A. Cadell, a visitor to Ravenna in the early 1800's (*A Journey in Carniola, Italy and France in the Years 1817, 1818*, vol. II, published in Edinburgh in 1820, noticed the use of stigma in the in-

understood³⁹, unless it is used as a kind of cryptic device to render the contents less intelligible to the general layman. A second possibility is that the Greek letter is used to sanctify a number⁴⁰ that was already recognized as a perfect number in the Christian literature⁴¹. However, there are notable exceptions to this rule in the table itself, where the regular writing VI is sometimes found instead of C: examples can be found in the third sector, first lines (*Lunae III Annus VI*), in the twelfth sector, second sentence (*Pascha VI Idus Apriles*), in the thirteen sector, always at the beginning (*Pascha VIII Kalendas Apriles*, instead of *Pascha CIII Kalendas Apriles*), in the seventeen sector (*Cyclus II Pascha VI Idus Apriles Lunae XVIII*

scription. While he correctly recognized the inscription and was even knowledgeable with the work of Noris («A drawing of the cycle of Ravenna is published by Cardinal Noris»), he failed to interpret correctly the stigma that he mistook for the letter G: «The number 6 is denoted by a figure something like a capital Roman G, and bearing some resemblance to the 6 now in use ; but the notation and the rest of the figures are Roman, and the Arabic or Indian figures, and the very ingenious and useful system of decimal notation, were not introduced in to Italy till Leonardo Fibonacci...».

³⁹ This may refer to an archaic usage, but the use of the symbol in early Christian epigraphy is not widespread; an inscription from Sabratha, brought to my attention by Prof. Paola Marone, is the only inscription in which the use of the symbol is attested (see G. Falzone, *Sabratha. Nota di epigrafia Cristiana*, in *Pagani e Cristiani a Sabratha e Leptis Magna tra III e VI secolo d.C. Monumenti e reperti, tradizione e immagini*, Atti del seminario di studio, Polo universitario della Provincia di Agrigento [26-27 gennaio 2012], page 139).

⁴⁰ An intriguing possibility, far from being proven, is a possible relationship between Early Christian sects, and in particular the Valentinians, with the Jewish Gematria (transposed in Greek language as Isopsephy). Even if of short duration, it is evident that some elements of Judaism permeated the early Christian communities, especially in the Near East, and following the dismissal of such ideas, some remnants may still have clung to the Early Christianity as the text of Augustine proves. A rather cryptic passage centered around the number 6 by Clement of Alexandria may provide a hint on the meaning of numbers in Early Christianity: «For the [number] six is included in the order of the numbers, but the sequence of the oral letters makes known that the ἐπίσημον is unwritten. Thus, according to the numbers themselves, each monad is preserved in sequence, up to the hebdomad and the ogdoad. But according to the number of oral letters, the zeta becomes sixth, and the eta seventh. But when the ἐπίσημον – I don't know how – slips into writing (should we pursue it in this manner) the hebdomad becomes the sixth [letter], and the ogdoad the seventh» (Clement of Alexandria, *Stromateis*, 6.140.4–6.141.1 from J. Kalvesmaki, *The Theology of Arithmetic, Number Symbolism in Platonism and Early Christianity*, Center for Hellenic Studies, 2013).

⁴¹ Augustinus, *De Civitate Dei*, liber XI, 30: «Perfectus est senarius numerus. Haec autem propter senarii numeri perfectionem eodem die sexiens repetito sex diebus perfecta narrantur, non quia Deo fuerit necessaria mora temporum, quasi qui non potuerit creare omnia simul, quae deinceps congruis motibus peragerent tempora; sed quia per senarium numerum est operum significata perfectio. Numerus quippe senarius primus completur suis partibus, id est sexta sui parte et tertia et dimidia, quae sunt unum et duo et tria, quae in summam ducta sex fiunt».

again instead of *Cyclus II Pascha V Idus Apriles Lunae XCII*) and finally in the eighteen sector (*Pascha VI Kalendas Apriles*).

In the transliteration, I have used the letter *C* instead of *Ċ* for the sake of simplicity and because this will not impair the meaning of the transliteration. In the translation to Latin, the digamma has been rendered as the number 6 within brackets (*VI*) to identify its use. Only one error is found in the compilation of the table: in the ninth sector, third cycle, the age of the Moon is given as 17, while it should be 16 instead.

Contents

It has been remarked above that the table starts with lunar cycle 1 (*Lunae primus*) which corresponds to the year 535 in the Bede's tables. Actually, the whole calendar is based on the lunar cycle, which differs from the 19-year Paschal cycle⁴² by 3 years: the year 1 of the lunar cycle corresponds to the year 4 of the 19-year cycle (see the correspondence in the Bede's Tables in Appendix A). This correspondence is explicitly stated in the first line of each sector, to enable the reader to map the calendar to one of the two cycles. The date of the XIII Moon (*Lunae XIII*) follows, date which is common to the five cycles of the sector.

Then for each of the five years sharing the same date for the XIII Moon (*Cyclus I* to *cyclus V*, the first is always implicit in the table, the others are explicitly declared) the date of Easter and the age of the Moon on the Easter day are given. Finally, the indication if the years belonging to the sector are common (*CM*) or embolismic (*EB*) closes the sector near the center of the slab.

⁴² On which the Bede's tables are based.

First sector



$$\overline{LV} \cdot \overline{PRIMVS} \cdot \overline{AN} \cdot \overline{IIII} \overline{L} \cdot \overline{XIIII} \cdot \overline{IIII} \overline{NO} \overline{AP}$$

$$\overline{PA} \cdot \overline{VI} \cdot \overline{ID} \overline{AP} \cdot \overline{LV} \cdot \overline{XX}$$

*Lunae Primus Annus IIII Lunae XIIII IIII Nonas Apriles
(Cyclus I) Pascha VI Idus Apriles Lunae XX*

First lunar year, fourth (of the 19-year cycle), the day XIIII (of the lunar month occurs on the) fourth (day preceding the) Nones of April (2 April)

(First cycle), Easter (occurs on the) sixth (day preceding the) Ides of April (8 April), the age of the Moon is 20.

$$\overline{CY} \cdot \overline{II} \cdot \overline{PAS} \cdot \overline{NO} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XCI}$$

Cyclus II Pascha Nonis Aprilibus Lunae X(VI)I

Second cycle, Easter occurs on the Nones of April (5 April), the age of the Moon is 17.

$$\overline{CY} \cdot \overline{III} \cdot \overline{PAS} \cdot \overline{V} \cdot \overline{ID} \cdot \overline{APR} \cdot \overline{LV} \cdot \overline{XXI}$$

Cyclus III Pascha V Idus Apriles Lunae XXI

Third cycle, Easter (occurs on the) fifth (day preceding the) Ides of April (9 April), the age of the Moon is 21.

$$\overline{CY} \cdot \overline{IIII} \cdot \overline{PA} \cdot \overline{CII} \cdot \overline{ID} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XCII}$$

Cyclus IIII, Pascha VIII Idus Apriles Lunae X(VI)II

Fourth cycle, Easter (occurs on the) eighth day preceding the Ides of April (6 April), the age of the Moon is 18.

$$\overline{CY} \cdot \overline{V} \cdot \overline{PA} \cdot \overline{PD} \cdot \overline{N} \cdot \overline{AP} \cdot \overline{L} \cdot \overline{XC}$$

Cyclus V, Pascha Pridie Nonas Apriles Lunae X(VI)

Fifth cycle, Easter (occurs on the) day preceding the Nones of April (4 April), the age of the Moon is 16.

$$\overline{CM}$$

Common Year (Non Embolismic)

Second Sector



$$\overline{LV} \cdot \overline{II} \cdot \overline{AN} \cdot \overline{V} \cdot \overline{L} \cdot \overline{XIII} \cdot \overline{XI} \cdot \overline{K} \cdot \overline{AP}$$

$$\overline{PA} \cdot \overline{X} \cdot \overline{K} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XV}$$

Lunae II Annus V Lunae XIII XI Kalendas Apriles
(Cyclos I) *Pascha X Kalendas Apriles Lunae XV*

Second lunar year, fifth (of the 19-year cycle), the day XIII (of the lunar month occurs on the) eleventh (day preceding the) Kalends of April (22 March)

(First cycle), Easter (occurs on the) tenth (day preceding the) Kalends of April (23 March), the age of the Moon is 15.

$$\overline{CY} \cdot \overline{II} \cdot \overline{PAS} \cdot \overline{V} \cdot \overline{K} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XX}$$

Cyclos II Pascha V Kalendas Apriles Lunae XX

Second cycle, Easter (occurs on the) fifth (day preceding the) Kalends of April (28 March), the age of the Moon is 20.

$$\overline{CY} \cdot \overline{III} \cdot \overline{PAS} \cdot \overline{VIII} \cdot \overline{K} \cdot \overline{APR} \cdot \overline{LV} \cdot \overline{XVII}$$

Cyclos III Pascha VIII Kalendas Apriles Lunae XVII

Third cycle, Easter (occurs on the) eighth (day preceding the) Kalends of April (25 March), the age of the Moon is 17.

$$\overline{CY} \cdot \overline{IIII} \cdot \overline{PA} \cdot \overline{IIII} \cdot \overline{K} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XXI}$$

Cyclos IIII, Pascha IIII Kalendas Apriles Lunae XXI

Fourth cycle, Easter (occurs on the) fourth (day preceding the) Kalends of April (29 March), the age of the Moon is 21.

$$\overline{CY} \cdot \overline{V} \cdot \overline{PA} \cdot \overline{CI} \cdot \overline{K} \cdot \overline{AP} \cdot \overline{L} \cdot \overline{XCII}$$

Cyclos V, Pascha (VI) Kalendas Apriles Lunae X(VI)II

Fifth cycle, Easter (occurs on the) seventh (day preceding the) Kalends of April (26 March), the age of the Moon is 18.

$$\overline{CM}$$

Common Year (Non Embolismic)

Third Sector



$$\overline{LV} \cdot \overline{III} \cdot \overline{AN} \cdot \overline{VI} \cdot \overline{L} \cdot \overline{XIII} \cdot \overline{IV} \cdot \overline{ID} \cdot \overline{AP}$$

$$\overline{PA} \cdot \overline{PR} \cdot \overline{ID} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XC}$$

*Lunae III Annus VI Lunae XIII IV Ides Apriles
(Cyclus I) Pascha Pridie Idus Apriles Lunae X(VI)*

Third lunar year, sixth (of the 19-year cycle), the day XIII (of the lunar month occurs on the) fourth (day preceding the) Ides of April (10 April)

(First cycle), Easter (occurs on the) day preceding the Ides of April (12 Aprile), the age of the Moon is 16.

$$\overline{CY} \cdot \overline{II} \cdot \overline{PAS} \cdot \overline{XC} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{LV} \cdot \overline{XX}$$

Cyclus II Pascha X(VI) Kalendas Maias Lunae XX

Second cycle, Easter (occurs on the) 16th (day preceding the) Kalends of May (16 April), the age of the Moon is 20.

$$\overline{CY} \cdot \overline{III} \cdot \overline{PAS} \cdot \overline{XCII} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{LV} \cdot \overline{XCII}$$

Cyclus III Pascha X(VI)II Kalendas Maias Lunae X(VI)II

Third cycle, Easter (occurs on the) 18th (day preceding the) Kalends of May (14 April), the age of the Moon is 18.

$$\overline{CY} \cdot \overline{IIII} \cdot \overline{PA} \cdot \overline{III} \cdot \overline{ID} \cdot \overline{APR} \cdot \overline{LV} \cdot \overline{XV}$$

Cyclus IIII, Pascha III Idus Apriles Lunae XV

Fourth cycle, Easter (occurs on the) third (day preceding the) Ides of April (11 April), the age of the Moon is 15.

$$\overline{CY} \cdot \overline{V} \cdot \overline{PA} \cdot \overline{XCI} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{L} \cdot \overline{XCI}$$

Cyclus V, Pascha X(VI)I Kalendas Maias Lunae X(VI)III

Fifth cycle, Easter (occurs on the) 17th (day preceding the) Kalends of May (15 April), the age of the Moon is 19.

$$\overline{EB}$$

Embolismic Year

Fourth Sector



$$\overline{LV} \cdot \overline{III} \cdot \overline{AN} \cdot \overline{CI} \cdot \overline{L} \cdot \overline{XIII} \cdot \overline{III} \cdot \overline{K} \cdot \overline{AP}$$

$$\overline{PA} \cdot \overline{PD} \cdot \overline{NO} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XCIII}$$

*Lunae IIII Annus (VI)I Lunae XIII III Kalendas Apriles
(Cyclus I) Pascha Pridie Nonas Apriles Lunae X(VI)III*

Fourth lunar year, seventh (of the 19-year cycle), the day XIII (of the lunar month occurs on the) third (day preceding the) Kalends of April (30 March)

(First cycle), Easter (occurs on the) day preceding the Nones of April (4 April), the age of the Moon is 19.

$$\overline{CY} \cdot \overline{II} \cdot \overline{PAS} \cdot \overline{K} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XC}$$

Cyclus II Pascha Kalendis Aprilibus Lunae X(VI)

Second cycle, Easter (occurs on the) Kalends of April (1 April), the age of the Moon is 16.

$$\overline{CY} \cdot \overline{III} \cdot \overline{PAS} \cdot \overline{NO} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XX}$$

Cyclus III Pascha Nonis Aprilibus Lunae XX

Third cycle, Easter (occurs on the) Nones of April (5 April), the age of the Moon is 20.

$$\overline{CY} \cdot \overline{IIII} \cdot \overline{PA} \cdot \overline{III} \cdot \overline{NO} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XCII}$$

Cyclus IIII, Pascha III Nonas Apriles Lunae X(VI)II

Fourth cycle, Easter (occurs on the) third (day preceding the) Nones of April (3 April), the age of the Moon is 18.

$$\overline{CY} \cdot \overline{V} \cdot \overline{PA} \cdot \overline{PD} \cdot \overline{K} \cdot \overline{AP} \cdot \overline{L} \cdot \overline{XV}$$

Cyclus V, Pascha Pridie Kalendas Apriles Lunae XV

Fifth cycle, Easter (occurs on the) day preceding the Kalends of April (31 March), the age of the Moon is 15.

$$\overline{CM}$$

Common Year (Non Embolismic)

Fifth Sector



$$\overline{LV} \cdot \overline{V} \cdot \overline{AN} \cdot \overline{CII} \cdot \overline{L} \cdot \overline{XIII} \cdot \overline{XIII} \cdot \overline{K} \cdot \overline{MAI}$$

$$\overline{PA} \cdot \overline{CII} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{LV} \cdot \overline{XX}$$

*Lunae V Annus (VI)II Lunae XIII XIII Kalendas Maias
(Cyclus I) Pascha (VI)II Kalendas Maias Lunae XX*

Fifth lunar year, eighth (of the 19-year cycle), the day XIII (of the lunar month occurs on the) 14th (day preceding the) Kalends of May (18 April)

(First cycle), Easter (occurs on the) eighth (day preceding the) Kalends of May (24 April), the age of the Moon is 20.

$$\overline{CY} \cdot \overline{II} \cdot \overline{PAS} \cdot \overline{XI} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{LV} \cdot \overline{XCI}$$

Cyclus II Pascha XI Kalendis Maias Lunae X(VI)I

Second cycle, Easter (occurs on the) 11th (day preceding the) Kalends of May (21 April), the age of the Moon is 17.

$$\overline{CY} \cdot \overline{III} \cdot \overline{PAS} \cdot \overline{VII} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{LV} \cdot \overline{XXI}$$

Cyclus III Pascha VII Kalendis Maias Lunae XXI

Third cycle, Easter (occurs on the) seventh (day preceding the) Kalends of May (25 April), the age of the Moon is 21.

$$\overline{CY} \cdot \overline{IIII} \cdot \overline{PA} \cdot \overline{X} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{LV} \cdot \overline{XCII}$$

Cyclus IIII, Pascha X Kalendis Maias Lunae X(VI)II

Fourth cycle, Easter (occurs on the) tenth (day preceding the) Kalends of May (22 April), the age of the Moon is 18.

$$\overline{CY} \cdot \overline{V} \cdot \overline{PA} \cdot \overline{XII} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{L} \cdot \overline{XC}$$

Cyclus V, Pascha XII Kalendas Maias Lunae X(VI)

Fifth cycle, Easter (occurs on the) 12th (day preceding the) Kalends of May (20 April), the age of the Moon is 16.

$$\overline{EB}$$

Embolismic Year

Sixth Sector

*DIVISIO · CYCLI · II*

$$\overline{LV} \cdot C \cdot \overline{AN} \cdot \overline{CIII} \cdot \overline{L} \cdot \overline{XIII} \cdot \overline{CI} \cdot \overline{ID} \cdot \overline{AP}$$

$$\overline{PA} \cdot C \cdot \overline{ID} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XV}$$

*Lunae (VI) Annus (VI) III Lunae XIII (VI) I Idus Apriles
(Cyclus I) Pascha (VI) Idus Apriles Lunae XV*

Sixth lunar year, ninth (of the 19-year cycle), the day XIII (of the lunar month occurs on the) seventh (day preceding the) Ides of April (7 April)

(First cycle), Easter (occurs on the) sixth (day preceding the) Ides of April (8 April), the age of the Moon is 15.

$$\overline{CY} \cdot \overline{II} \cdot \overline{PAS} \cdot \overline{ID} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XX}$$

Cyclus II Pascha Idibus Aprilibus Lunae XX

Second cycle, Easter (occurs on the) Ides of April (13 April), the age of the Moon is 20.

$$\overline{CY} \cdot \overline{III} \cdot \overline{PAS} \cdot \overline{III} \cdot \overline{ID} \cdot \overline{APR} \cdot \overline{LV} \cdot \overline{XCI}$$

Cyclus III Pascha III Idus Apriles Lunae X(VI)I

Third cycle, Easter (occurs on the) fourth (day preceding the) Ides of April (10 April), the age of the Moon is 17.

$$\overline{CY} \cdot \overline{IIII} \cdot \overline{PA} \cdot \overline{XCII} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{LV} \cdot \overline{XXI}$$

Cyclus IIII, Pascha X(VI)II Kalendas Maias Lunae XXI

Fourth cycle, Easter (occurs on the) 18th (day preceding the) Kalends of May (14 April), the age of the Moon is 21.

$$\overline{CY} \cdot \overline{V} \cdot \overline{PA} \cdot \overline{III} \cdot \overline{ID} \cdot \overline{AP} \cdot \overline{L} \cdot \overline{XCII}$$

Cyclus V, Pascha III Idus Apriles Lunae X(VI)II

Fifth cycle, Easter (occurs on the) third (day preceding the) Ides of April (11 April), the age of the Moon is 18.

$$\overline{CM}$$

Common Year (Non Embolismic)

Seventh Sector



$$\overline{LV} \cdot \overline{CI} \cdot \overline{AN} \cdot \overline{X} \cdot \overline{LV} \cdot \overline{XIII} \cdot \overline{VI} \cdot \overline{K} \cdot \overline{AP}$$

$$\overline{PA} \cdot \overline{PD} \cdot \overline{K} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XCII}$$

*Lunae (VI)I Annus X Lunae XIII (VI) Kalendas Apriles
(Cyclus I) Pascha Pridie Kalendas Apriles Lunae X(VI)II*

Seventh lunar year, tenth (of the 19-year cycle), the day XIII (of the lunar month occurs on the) sixth (day preceding the) Kalends of April (27 March)

(First cycle), Easter (occurs on the) day preceding the Kalends of April (31 March), the age of the Moon is 18.

$$\overline{CY} \cdot \overline{II} \cdot \overline{PAS} \cdot \overline{V} \cdot \overline{K} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XV}$$

Cyclus II Pascha V Kalendas Apriles Lunae XV

Second cycle, Easter (occurs on the) fifth (day preceding the) Kalends of April (28 March), the age of the Moon is 15.

$$\overline{CY} \cdot \overline{III} \cdot \overline{PAS} \cdot \overline{III} \cdot \overline{NO} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XX}$$

Cyclus III Pascha III Nonas Apriles Lunae XX

Third cycle, Easter (occurs on the) fourth (day preceding the) Nones of April (2 April), the age of the Moon is 20.

$$\overline{CY} \cdot \overline{III} \cdot \overline{PA} \cdot \overline{III} \cdot \overline{K} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XCI}$$

Cyclus IIII, Pascha III Kalendas Apriles Lunae X(VI)I

Fourth cycle, Easter (occurs on the) third (day preceding the) Kalends of April (30 March), the age of the Moon is 17.

$$\overline{CY} \cdot \overline{V} \cdot \overline{PA} \cdot \overline{III} \cdot \overline{N} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XXI}$$

Cyclus V, Pascha III Nonas Apriles Lunae XXI

Fifth cycle, Easter (occurs on the) third (day preceding the) Nones of April (3 April), the age of the Moon is 21.

$$\overline{CM}$$

Common Year (Non Embolismic)

Eight Sector

$$\overline{LV} \cdot \overline{CH} \cdot \overline{AN} \cdot \overline{XI} \cdot \overline{L} \cdot \overline{XIII} \cdot \overline{XCI} \cdot \overline{K} \cdot \overline{MAI}$$

$$\overline{PA} \cdot \overline{XII} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{LV} \cdot \overline{XCIII}$$

*Lunae (VI)II Annus XI Lunae XIII X(VI)I Kalendas
Maías*

(Cyclus I) Pascha XII Kalendas Maías Lunae X(VI)III

Eighth lunar year,eleventh (of the 19-year cycle), the day XIII (of the lunar month occurs on the) 17th (day preceding the) Kalends of May (15 April)

(First cycle), Easter (occurs on the) 12th (day preceding the) Kalends of May (20 April), the age of the Moon is 19.

$$\overline{CY} \cdot \overline{II} \cdot \overline{PAS} \cdot \overline{XV} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{LV} \cdot \overline{XC}$$

Cyclus II Pascha XV Kalendas Maías Lunae X(VI)

Second cycle, Easter (occurs on the) 15th (day preceding the) Kalends of May (17 April), the age of the Moon is 16.

$$\overline{CY} \cdot \overline{III} \cdot \overline{PAS} \cdot \overline{XI} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{LV} \cdot \overline{XX}$$

Cyclus III Pascha XI Kalendas Maías Lunae XX

Third cycle, Easter (occurs on the) eleventh (day preceding the) Kalends of May (21 April), the age of the Moon is 20.

$$\overline{CY} \cdot \overline{III} \cdot \overline{PA} \cdot \overline{XIII} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{LV} \cdot \overline{XCII}$$

Cyclus IIII, Pascha XIII Kalendas Maías Lunae X(VI)II

Fourth cycle, Easter (occurs on the) 13th (day preceding the) Kalends of May (19 April), the age of the Moon is 18.

$$\overline{CY} \cdot \overline{V} \cdot \overline{PA} \cdot \overline{XC} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{L} \cdot \overline{XV}$$

Cyclus V, Pascha X(VI) Kalendas Maías Lunae XV

Fifth cycle, Easter (occurs on the) 16th (day preceding the) Kalends of May (16 April), the age of the Moon is 15.

$$\overline{EB}$$

Embolismic Year

Ninth Sector



$$\overline{LV} \cdot \overline{CIII} \cdot \overline{AN} \cdot \overline{XII} \cdot \overline{L} \cdot \overline{XIII} \cdot \overline{PD} \cdot \overline{NO} \cdot \overline{AP}$$

$$\overline{PA} \cdot \overline{NO} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XV}$$

*Lunae (VI)III Annus XII Lunae XIII Pridie Nonas
Apriles*

(Cyclos I) Pascha Nonis Aprilibus Lunae XV

Ninth lunar year, twelfth (of the 19-year cycle), the day XIII (of the lunar month occurs on the) day preceding the Nones of April (4 April)

(First cycle), Easter (occurs on the) Nones of April (5 April), the age of the Moon is 15.

$$\overline{CY} \cdot \overline{II} \cdot \overline{PAS} \cdot \overline{V} \cdot \overline{ID} \cdot \overline{AP} \cdot \overline{L} \cdot \overline{XIII}$$

Cyclos II Pascha V Idus Apriles Lunae X(VI)III

Second cycle, Easter (occurs on the) fifth (day preceding the) Ides of April (9 April), the age of the Moon is 19.

$$\overline{CY} \cdot \overline{III} \cdot \overline{PAS} \cdot \overline{CII} \cdot \overline{ID} \cdot \overline{APR} \cdot \overline{LV} \cdot \overline{XCI}$$

Cyclos III Pascha (VI)II Idus Apriles Lunae X(VI)I

Third cycle, Easter (occurs on the) eighth (day preceding the) Ides of April (6 April), the age of the Moon is 17⁴³.

$$\overline{CY} \cdot \overline{IIII} \cdot \overline{PA} \cdot \overline{IIII} \cdot \overline{ID} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XX}$$

Cyclos IIII, Pascha IIII Idus Apriles Lunae XX

Fourth cycle, Easter (occurs on the) fourth (day preceding the) Ides of April (10 April), the age of the Moon is 20.

$$\overline{CY} \cdot \overline{V} \cdot \overline{PA} \cdot \overline{C} \cdot \overline{ID} \cdot \overline{AP} \cdot \overline{L} \cdot \overline{XCII}$$

Cyclos V, Pascha (VI) Idus Apriles Lunae X(VI)II

Fifth cycle, Easter (occurs on the) sixth (day preceding the) Ides of April (8 April), the age of the Moon is 18.

$$\overline{CM}$$

Common Year (Non Embolismic)

⁴³ Here the writer has made an error, since the correct age of the Moon should be 16 for the date given, since the XIII of the lunar months occurs on April 4. This is also consistent with the data reported in the Bede's tables. The error was already noted in early scholars, see ref. [C4], page 303: «Legendum tamen esset XVI, ut cuicumque patet». Note that, in [C4], page 303, the cycle is erroneously identified as «Cycli Secundi decemnovennalis an. 12», while it should have been «Cycli Tertii decemnovennalis»!

Tenth Sector



$$\overline{LV} \cdot X \cdot \overline{AN} \cdot XIII \cdot \overline{L} \cdot XIII \cdot CIII \cdot \overline{K} \cdot \overline{AP}$$

$$\overline{PA} \cdot C \cdot \overline{K} \cdot \overline{AP} \cdot \overline{LV} \cdot XCI$$

*Lunae X Annus XIII Lunae XIII (VI)III Kalendas Apriles
(Cyclus I) Pascha (VI) Kalendas Apriles Lunae X(VI)I*

Tenth lunar year, thirteenth (of the 19-year cycle), the day XIII (of the lunar month occurs on the) ninth (day preceding the) Kalends of April (24 March)

(First cycle), Easter (occurs on the) sixth (day preceding the) Kalends of April (27 March), the age of the Moon is 17.

$$\overline{CY} \cdot II \cdot \overline{PAS} \cdot VIII \cdot \overline{K} \cdot \overline{AP} \cdot \overline{LV} \cdot XV$$

Cyclus II Pascha VIII Kalendas Apriles Lunae XV

Second cycle, Easter (occurs on the) eighth (day preceding the) Kalends of April (25 March), the age of the Moon is 15.

$$\overline{CY} \cdot III \cdot \overline{PAS} \cdot IIII \cdot \overline{K} \cdot \overline{APR} \cdot \overline{LV} \cdot XCIII$$

Cyclus III Pascha IIII Kalendas Apriles Lunae X(VI)III

Third cycle, Easter (occurs on the) fourth (day preceding the) Kalends of April (29 March), the age of the Moon is 19.

$$\overline{CY} \cdot IIII \cdot \overline{PA} \cdot CI \cdot \overline{K} \cdot \overline{AP} \cdot \overline{LV} \cdot XC$$

Cyclus IIII, Pascha(VI)I Kalendas Apriles Lunae X(VI)

Fourth cycle, Easter (occurs on the) seventh (day preceding the) Kalends of April (26 March), the age of the Moon is 16.

$$\overline{CY} \cdot V \cdot \overline{PA} \cdot III \cdot \overline{K} \cdot \overline{AP} \cdot \overline{L} \cdot XX$$

Cyclus V, Pascha III Kalendas Apriles Lunae XX

Fifth cycle, Easter (occurs on the) third (day preceding the) Kalends of April (30 March), the age of the Moon is 20.

$$\overline{CM}$$

Common Year (Non Embolismic)

Eleventh Sector



$$\overline{LV} \cdot \overline{XI} \cdot \overline{AN} \cdot \overline{XIII} \cdot \overline{L} \cdot \overline{XIII} \cdot \overline{PD} \cdot \overline{ID} \cdot \overline{AP}$$

$$\overline{PA} \cdot \overline{XC} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{LV} \cdot \overline{XCII}$$

Lunae XI Annus XIII Lunae XIII Pridie Idus Apriles
(Cyclus I) Pascha X(VI) Kalendas Maias Lunae X(VI)II

Eleventh lunar year, fourteenth (of the 19-year cycle), the day XIII (of the lunar month occurs on the) day preceding the Ides of April (12 April)

(First cycle), Easter (occurs on the) 16th (day preceding the) Kalends of May (16 April), the age of the Moon is 18.

$$\overline{CY} \cdot \overline{II} \cdot \overline{PAS} \cdot \overline{ID} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XV}$$

Cyclus II Pascha Idibus Aprilibus Lunae XV

Second cycle, Easter (occurs on the) Ides of April (13 April), the age of the Moon is 15.

$$\overline{CY} \cdot \overline{III} \cdot \overline{PAS} \cdot \overline{XIII} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{LV} \cdot \overline{XX}$$

Cyclus III Pascha XIII Kalendas Maias Lunae XX

Third cycle, Easter (occurs on the) fourteenth (day preceding the) Kalends of May (18 April), the age of the Moon is 20.

$$\overline{CY} \cdot \overline{IIII} \cdot \overline{PA} \cdot \overline{XCI} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{LV} \cdot \overline{XCI}$$

Cyclus IIII, Pascha X(VI)I Kalendas Maias Lunae X(VI)I

Fourth cycle, Easter (occurs on the) 17th (day preceding the) Kalends of May (15 April), the age of the Moon is 17.

$$\overline{CY} \cdot \overline{V} \cdot \overline{PA} \cdot \overline{XIII} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{L} \cdot \overline{XXI}$$

Cyclus V, Pascha XIII Kalendas Maias Lunae XXI

Fifth cycle, Easter (occurs on the) 13th (day preceding the) Kalends of May (19 April), the age of the Moon is 21.

$$\overline{EB}$$

Embolismic Year

Twelfth Sector



$$\overline{LV} \cdot \overline{XII} \cdot \overline{AN} \cdot \overline{XV} \cdot \overline{L} \cdot \overline{XIII} \cdot \overline{K} \cdot \overline{AP}$$

$$\overline{PA} \cdot \overline{VI} \cdot \overline{ID} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XXI}$$

*Lunae XII Annus XV Lunae XIII Kalendis Aprilibus
(Cyclus I) Pascha VI Idus Apriles Lunae XXI*

Twelfth lunar year, fifteenth (of the 19-year cycle), the day XIII (of the lunar month occurs on the) Kalends of April (1 April)

(First cycle), Easter (occurs on the) sixth (day preceding the) Ides of April (8 April), the age of the Moon is 21.

$$\overline{CY} \cdot \overline{II} \cdot \overline{PAS} \cdot \overline{NO} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XCII}$$

Cyclus II Pascha Nonis Aprilibus Lunae X(VI)II

Second cycle, Easter (occurs on the) Nones of April (5 April), the age of the Moon is 18.

$$\overline{CY} \cdot \overline{III} \cdot \overline{PAS} \cdot \overline{IIII} \cdot \overline{NO} \cdot \overline{APR} \cdot \overline{LV} \cdot \overline{XV}$$

Cyclus III Pascha IIII Nonas Apriles Lunae XV

Third cycle, Easter (occurs on the) fourth (day preceding the) Nones of April (2 April), the age of the Moon is 15.

$$\overline{CY} \cdot \overline{IIII} \cdot \overline{PA} \cdot \overline{CI} \cdot \overline{ID} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XX}$$

Cyclus IIII, Pascha (VI)I Idus Apriles Lunae XX

Fourth cycle, Easter (occurs on the) seventh (day preceding the) Ides of April (7 April), the age of the Moon is 20.

$$\overline{CY} \cdot \overline{V} \cdot \overline{PA} \cdot \overline{PD} \cdot \overline{N} \cdot \overline{AP} \cdot \overline{L} \cdot \overline{XCI}$$

Cyclus V, Pascha Pridie Nonas Apriles Lunae X(VI)I

Fifth cycle, Easter (occurs on the) day preceding the Nones of April (4 April), the age of the Moon is 17.

$$\overline{CM}$$

Common Year (Non Embolismic)

Thirteenth Sector



$$[\overline{LV}] \cdot \overline{XIII} \cdot \overline{AN} \cdot \overline{XC} \cdot \overline{L} \cdot \overline{XIII} \cdot \overline{XII} \cdot \overline{K} \cdot \overline{AP}$$

$$\overline{PA} \cdot \overline{VIII} \cdot \overline{K} \cdot \overline{AP} \cdot \overline{L} \cdot \overline{XCI}$$

[Lunae] XIII Annus X(VI) Lunae XIII XII Kalendas Apriles
(Cyclos I) Pascha VIII Kalendas Apriles Lunae X(VI)I

Thirteenth lunar year, sixteenth (of the 19-year cycle), the day XIII (of the lunar month occurs on the) 12th (day preceding the) Kalends of April (21 March)

(First cycle), Easter (occurs on the) ninth (day preceding the) Kalends of April (24 March), the age of the Moon is 17.

$$\overline{CY} \cdot \overline{II} \cdot \overline{PAS} \cdot \overline{V} \cdot \overline{K} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XXI}$$

Cyclos II Pascha V Kalendas Apriles Lunae XXI

Second cycle, Easter (occurs on the) fifth (day preceding the) Kalends of April (28 March), the age of the Moon is 21.

$$\overline{CY} \cdot \overline{III} \cdot \overline{PAS} \cdot \overline{CII} \cdot \overline{K} \cdot \overline{APR} \cdot \overline{LV} \cdot \overline{XCII}$$

Cyclos III Pascha (VI)II Kalendas Apriles Lunae X(VI)II

Third cycle, Easter (occurs on the) eighth (day preceding the) Kalends of April (25 March), the age of the Moon is 18.

$$\overline{CY} \cdot \overline{IIII} \cdot \overline{PA} \cdot \overline{XI} \cdot \overline{K} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XV}$$

Cyclos IIII, Pascha XI Kalendas Apriles Lunae XV

Fourth cycle, Easter (occurs on the) eleventh (day preceding the) Kalends of April (22 March), the age of the Moon is 15.

$$\overline{CY} \cdot \overline{V} \cdot \overline{PA} \cdot \overline{C} \cdot \overline{K} \cdot \overline{AP} \cdot \overline{L} \cdot \overline{XX}$$

Cyclos V, Pascha (VI) Kalendas Apriles Lunae XX

Fifth cycle, Easter (occurs on the) sixth (day preceding the) Kalends of April (27 March), the age of the Moon is 20.

$$\overline{CM}$$

Common Year (Non Embolismic)

Fourteenth Sector


$$\overline{LV} \cdot \overline{XIII} \cdot \overline{AN} \cdot \overline{XCI} \cdot \overline{L} \cdot \overline{XIII} \cdot \overline{V} \cdot \overline{ID} \cdot \overline{AP}$$

$$\overline{PA} \cdot \overline{PD} \cdot \overline{ID} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XCI}$$

*Lunae XIII Annus X(VI)I Lunae XIII V Idus Apriles
(Cyclus I) Pascha Pridie Idus Apriles Lunae X(VI)I*

Fourteenth lunar year, seventeenth (of the 19-year cycle),
the day XIII (of the lunar month occurs on the) fifth (day
preceding the) Ides of April (9 April)

(First cycle), Easter (occurs on the) day preceding the Ides of April (12 April), the age of the Moon is 17.

$$\overline{CY} \cdot II \cdot \overline{PAS} \cdot IIII \cdot \overline{ID} \cdot \overline{AP} \cdot \overline{L} \cdot XV$$

Cyclus II Pascha IIII Idus Apriles Lunae XV

Second cycle, Easter (occurs on the) fourth (day preceding the) Ides of April (10 April), the age of the Moon is 15.

$$\overline{CY} \cdot III \cdot \overline{PAS} \cdot XCII \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{LV} \cdot XCIII$$

Cyclus III Pascha X(VI)II Kalendas Maias Lunae X(VI)III

Third cycle, Easter (occurs on the) 18th (day preceding the) Kalends of May (14 April), the age of the Moon is 19.

$$\overline{CY} \cdot IIII \cdot \overline{PA} \cdot III \cdot \overline{ID} \cdot \overline{AP} \cdot \overline{LV} \cdot XC$$

Cyclus IIII, Pascha III Idus Apriles Lunae X(VI)

Fourth cycle, Easter (occurs on the) third (day preceding the) Ides of April (11 April), the age of the Moon is 16.

$$\overline{CY} \cdot V \cdot \overline{PA} \cdot XCI \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{L} \cdot XX$$

Cyclus V, Pascha X(VI)I Kalendas Maias Lunae XX

Fifth cycle, Easter (occurs on the) 17th (day preceding the) Kalends of May (15 April), the age of the Moon is 20.

$$\overline{EB}$$

Embolismic Year

Fifteenth Sector



$$\overline{LV} \cdot \overline{XV} \cdot \overline{AN} \cdot \overline{XCII} \cdot \overline{L} \cdot \overline{XIII} \cdot \overline{III} \cdot \overline{K} \cdot \overline{AP}$$

$$\overline{PA} \cdot \overline{PD} \cdot \overline{NO} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XX}$$

*Lunae XV Annus X(VI)II Lunae XIII IIII Kalendas Apriles
(Cyclus I) Pascha Pridie Nonas Apriles Lunae XX*

Fifteenth lunar year, eighteenth (of the 19-year cycle), the day XIII (of the lunar month occurs on the) fourth (day preceding the) Kalends of April (29 March)

(First cycle), Easter (occurs on the) day preceding the Nones of April (4 April), the age of the Moon is 20.

$$\overline{CY} \cdot \overline{II} \cdot \overline{PAS} \cdot \overline{K} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XCI}$$

Cyclus II Pascha Kalendis Aprilibus Lunae X(VI)I

Second cycle, Easter (occurs on the) Kalends of April (1 April), the age of the Moon is 17.

$$\overline{CY} \cdot \overline{III} \cdot \overline{PAS} \cdot \overline{III} \cdot \overline{K} \cdot \overline{APR} \cdot \overline{LV} \cdot \overline{XV}$$

Cyclus III Pascha III Kalendas Apriles Lunae XV

Third cycle, Easter (occurs on the) third (day preceding the) Kalends of April (30 March), the age of the Moon is 15.

$$\overline{CY} \cdot \overline{IIII} \cdot \overline{PA} \cdot \overline{III} \cdot \overline{NO} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XCIII}$$

Cyclus IIII, Pascha III Nonas Apriles Lunae X(VI)III

Fourth cycle, Easter (occurs on the) third (day preceding the) Nones of April (3 April), the age of the Moon is 19.

$$\overline{CY} \cdot \overline{V} \cdot \overline{PA} \cdot \overline{PD} \cdot \overline{K} \cdot \overline{AP} \cdot \overline{L} \cdot \overline{XC}$$

Cyclus V, Pascha Pridie Kalendas Apriles Lunae X(VI)

Fifth cycle, Easter (occurs on the) day preceding the Kalends of April (31 March), the age of the Moon is 16.

$$\overline{CM}$$

Common Year (Non Embolismic)

Sixteenth Sector



$$\overline{LV} \cdot \overline{XC} \cdot \overline{AN} \cdot \overline{XCIII} \cdot \overline{L} \cdot \overline{XIII} \cdot \overline{XV} \cdot \overline{K} \cdot \overline{MAI}$$

$$\overline{PA} \cdot \overline{CII} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{LV} \cdot \overline{XXI}$$

*Lunae X(VI) Annus X(VD)III Lunae XIII XV Kalendas Maias
(Cyclus I) Pascha (VI)II Kalendas Maias Lunae XXI*

Sixteenth lunar year, nineteenth (of the 19-year cycle), the day XIII (of the lunar month occurs on the) 15th (day preceding the) Kalends of May (17 April)

(First cycle), Easter (occurs on the) eighth (day preceding the) Kalends of May (24 April), the age of the Moon is 21.

$$\overline{CY} \cdot \overline{II} \cdot \overline{PAS} \cdot \overline{XI} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{LV} \cdot \overline{XCII}$$

Cyclus II Pascha XI Kalendis Maias Lunae X(VI)II

Second cycle, Easter (occurs on the) eleventh (day preceding the) Kalends of May (21 April), the age of the Moon is 18.

$$\overline{CY} \cdot \overline{III} \cdot \overline{PAS} \cdot \overline{XIII} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{LV} \cdot \overline{XV}$$

Cyclus III Pascha XIII Kalendas Maias Lunae XV

Third cycle, Easter (occurs on the) 14th (day preceding the) Kalends of May (18 April), the age of the Moon is 15.

$$\overline{CY} \cdot \overline{IIII} \cdot \overline{PA} \cdot \overline{CIII} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{LV} \cdot \overline{XX}$$

Cyclus IIII, Pascha (VI)III Kalendas Maias Lunae XX

Fourth cycle, Easter (occurs on the) ninth (day preceding the) Kalends of May (23 April), the age of the Moon is 20.

$$\overline{CY} \cdot \overline{V} \cdot \overline{PA} \cdot \overline{XII} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{L} \cdot \overline{XCI}$$

Cyclus V, Pascha XII Kalendas Maias Lunae X(VI)I

Fifth cycle, Easter (occurs on the) twelfth (day preceding the) Kalends of May (20 April), the age of the Moon is 17.

$$\overline{EB}$$

Embolismic Year

Seventeenth Sector



$$\overline{LV} \cdot \overline{XCI} \cdot \overline{AN} \cdot \overline{I} \cdot \overline{L} \cdot \overline{XIII} \cdot \overline{NO} \cdot \overline{AP}$$

$$\overline{PAS} \cdot \overline{III} \cdot \overline{ID} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XX}$$

*Lunae X(VI)I Annus I Lunae XIII Nonis Aprilibus
(Cyclus I) Pascha III Idus Apriles Lunae XX*

Seventeenth lunar year, first (of the 19-year cycle), the day XIII (of the lunar month occurs on the) Nones of April (5 April)

(First cycle), Easter (occurs on the) third (day preceding the) Ides of April (11 April), the age of the Moon is 20.

$$\overline{CY} \cdot \overline{II} \cdot \overline{PAS} \cdot \overline{V} \cdot \overline{ID} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XVIII}$$

Cyclus II Pascha V Idus Apriles Lunae XVIII

Second cycle, Easter (occurs on the) fifth (day preceding the) Ides of April (9 April), the age of the Moon is 18.

$$\overline{CY} \cdot \overline{III} \cdot \overline{PAS} \cdot \overline{CII} \cdot \overline{ID} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XV}$$

Cyclus III Pascha XIII Kalendas Maias Lunae XV

Third cycle, Easter (occurs on the) eighth (day preceding the) Ides of April (6 April), the age of the Moon is 15.

$$\overline{CY} \cdot \overline{IIII} \cdot \overline{PA} \cdot \overline{IIII} \cdot \overline{ID} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XCIII}$$

Cyclus IIII, Pascha IIII Idus Apriles Lunae X(VI)IIII

Fourth cycle, Easter (occurs on the) fourth (day preceding the) Ides of April (10 April), the age of the Moon is 19.

$$\overline{CY} \cdot \overline{V} \cdot \overline{PA} \cdot \overline{CI} \cdot \overline{ID} \cdot \overline{AP} \cdot \overline{L} \cdot \overline{XC}$$

Cyclus V, Pascha (VI)I Idus Apriles Lunae X(VI)

Fifth cycle, Easter (occurs on the) seventh (day preceding the) Ides of April (7 April), the age of the Moon is 16.

$$\overline{CM}$$

Common Year (Non Embolismic)

Eighteenth Sector



$$\overline{LV} \cdot \overline{XCII} \cdot \overline{AN} \cdot \overline{II} \cdot \overline{L} \cdot \overline{XIII} \cdot \overline{CII} \cdot \overline{K} \cdot \overline{AP}$$

$$\overline{PAS} \cdot \overline{VI} \cdot \overline{K} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XC}$$

*Lunae X(VI)II Annus II Lunae XIII (VI)II Kalendas Apriles
(Cyclus I) Pascha VI Kalendas Apriles Lunae X(VI)*

Eighteenth lunar year, second (of the 19-year cycle), the day XIII (of the lunar month occurs on the) eighth (day preceding the) Kalends of April (25 March)

(First cycle), Easter (occurs on the) sixth (day preceding the) Kalends of April (27 March), the age of the Moon is 16.

$$\overline{CY} \cdot \overline{II} \cdot \overline{PAS} \cdot \overline{PD} \cdot \overline{K} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XX}$$

Cyclus II Pascha Pridie Kalendas Apriles Lunae XX

Second cycle, Easter (occurs on the) day preceding the Kalends of April (31 March), the age of the Moon is 20.

$$\overline{CY} \cdot \overline{III} \cdot \overline{PAS} \cdot \overline{III} \cdot \overline{K} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XCII}$$

Cyclus III Pascha III Kalendas Apriles Lunae X(VI)II

Third cycle, Easter (occurs on the) fourth (day preceding the) Kalends of April (29 March), the age of the Moon is 18.

$$\overline{CY} \cdot \overline{III} \cdot \overline{PA} \cdot \overline{CI} \cdot \overline{K} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XV}$$

Cyclus IIII, Pascha (VI)I Kalendas Apriles Lunae XV

Fourth cycle, Easter (occurs on the) seventh (day preceding the) Kalends of April (26 March), the age of the Moon is 15.

$$\overline{CY} \cdot \overline{V} \cdot \overline{PA} \cdot \overline{III} \cdot \overline{K} \cdot \overline{AP} \cdot \overline{L} \cdot \overline{XCIII}$$

Cyclus V, Pascha III Kalendas Apriles Lunae X(VI)III

Fifth cycle, Easter (occurs on the) third (day preceding the) Kalends of April (30 March), the age of the Moon is 19.

$$\overline{CM}$$

Common Year (Non Embolismic)

Nineteenth Sector



$$\overline{LV} \cdot \overline{XCIII} \cdot \overline{AN} \cdot \overline{III} \cdot \overline{L} \cdot \overline{XIII} \cdot \overline{ID} \cdot \overline{APR}$$

$$\overline{PA} \cdot \overline{XC} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{LV} \cdot \overline{XCI}$$

*Lunae X(VI)III Annus III Lunae XIII Idibus Aprilibus
(Cyclus I) Pascha X(VI) Kalendas Maias Lunae X(VI)I*

Nineteenth lunar year, third (of the 19-year cycle), the day XIII (of the lunar month occurs on the) Ides of April (13 April)

(First cycle), Easter (occurs on the) 16th (day preceding the) Kalends of May (16 April), the age of the Moon is 17.

$$\overline{CY} \cdot \overline{II} \cdot \overline{PAS} \cdot \overline{XII} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{L} \cdot \overline{XXI}$$

Cyclus II Pascha XII Kalendas Maias Lunae XXI

Second cycle, Easter (occurs on the) twelfth (day preceding the) Kalends of May (20 April), the age of the Moon is 21.

$$\overline{CY} \cdot \overline{III} \cdot \overline{PAS} \cdot \overline{XV} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{LV} \cdot \overline{XCII}$$

Cyclus III Pascha XV Kalendas Maias Lunae X(VI)II

Third cycle, Easter (occurs on the) 15th (day preceding the) Kalends of May (17 April), the age of the Moon is 18.

$$\overline{CY} \cdot \overline{IIII} \cdot \overline{PA} \cdot \overline{XCI} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{LV} \cdot \overline{XC}$$

Cyclus IIII, Pascha X(VI)I Kalendas Maias Lunae X(VI)

Fourth cycle, Easter (occurs on the) 17th (day preceding the) Kalends of May (15 April), the age of the Moon is 16.

$$\overline{CY} \cdot \overline{V} \cdot \overline{PA} \cdot \overline{XIII} \cdot \overline{K} \cdot \overline{MAI} \cdot \overline{L} \cdot \overline{XX}$$

Cyclus V, Pascha XIII Kalendas Maias Lunae XX

Fifth cycle, Easter (occurs on the) 13th (day preceding the) Kalends of May (19 April), the age of the Moon is 20.

$$\overline{EB}$$

Embolismic Year

APPENDIX

MATHEMATICAL STRUCTURE OF THE RAVENNA AND BEDE'S TABLES

Since the Ravenna calendar closely replicates the Bede's tables (see Table III for the correspondence of the contents), the mathematical derivation of the latter will provide a close insight of the contents of the Ravenna Paschal calendar and of the calculations that were the foundation of the medieval *computus*, i.e.: the computation of the date of Easter.

The derivation that follows has been programmed in the accompanying Excel spreadsheet that mechanizes the table's computations. The derivation has been strictly based on Bede's own recipes, since I soon discovered that it will be unnecessary and unwise to follow strict astronomical rules in the computation, for instance, of the full Moon; deviations from astronomical «truth» are the rule more than the exception for Medieval computists, that tried to adhere more to the orthodoxy of the *computus* rules than to the observations.

Lunar cycles in the medieval computus

As stated previously, there are two parallel cycles of 19 years running in the Paschal *computus*, in the Ravenna calendar as well as in the Bede's tables, shifted by 4 years with respect to each other.

The 19-year Paschal cycle

The Bede's tables are ordered by the first of these two cycles, the one starting with Lunar Epact zero, which I refer to as to the 19-year Paschal cycle. Therefore, the first line of the Bede's tables, for the year 532 AD, corresponds to the first year of the 19-year Paschal cycle.

As you may notice from a cursory look at the first line of the table (Figure 2), the Lunar Epact shows a characteristic entry of 0. This is the marker for the start of the 19-year Paschal cycle.

- The Epacts in the 19-year lunar cycle specifically stand for the age of the Moon on the 11th day prior to the Calends of April (22 March), since this is the beginning of the Paschal period (marked by the occurrence of the spring equinox on March 21). *A Lunar Epact 0 means that the Paschal lunar month (new Moon) starts immediately after the spring equinox for that particular year.*

The lunar cycle

The second cycle, which is instead the cycle by which the Ravenna calendar is ordered, is referred in the Bede's tables as the lunar cycle. This lunar cycle, 19 years again in duration, starts with the year 4 of the 19-year cycle and traces back its origin to the work of Victorius of Aquitaine (see *The contribution of Victorius of Aquitaine*).

Structure of the Bede's tables

But let's start by examining the Bede's tables entries (Figure 2).

Bede's 532 Years Paschal Table								
A.D.	A.D.	Indiction	Lunar epact	Concurrent	Lunar cycle	14th Moon	Easter	Moon on Easter day
-1	532	10	0	4	17	5 April	11 April	20
1	533	11	11	5	18	25 March	27 March	16
2	534	12	22	6	19	13 April	16 April	17
3	535	13	3	7	1	2 April	8 April	20
4	536	14	14	2	2	22 March	23 March	15

Figure 2. Bede's tables structure

Start from column 2 of the table, listing the years from 532 AD to year 1063 AD, for a total of 532 years corresponding to the famous cycle of Victorius of Aquitaine. Since the dates repeat after 532 years, the first column refers to the first cycle, starting on the year – 1 AD and ending on 531 AD. While for the first column the dates of Easter repeat, it is not so for other quantities in the table, for instance for the indiction, since 532 is not an exact multiple of 15. Therefore, use the first column for reference to the Easter dates only and consider all other entries valid only for the years marked in the second column of the table (which are the years of interest anyway).

The first year starts with lunar epact zero, corresponding to the first year of the cycle of 19-years. For the calendar in Ravenna, the sectors are ordered according to the lunar cycle (column 6) instead.

Computation of the Indiction

The computist would have likely progressed in his computations following the table structure itself, first computing the Indiction for the given year.

The Indiction is a 15-year cycle constructed for administrative (taxation) purposes. According to Bede, it can be computed very easily following his instructions:

Take the years from the Incarnation of our Lord, however many they may be: for instance, the present¹ year 725. Always add 3, because according to Dionysius² our Lord was born in the fourth indiction: this makes 728. Divide this by 15: 15 times 40 is 600, 15 times 8 are 120, and there are 8 left over. It is the eighth indiction. If nothing is left over, it is the 15th indiction³.

Therefore, in modern terms, let Y be the year and I the indiction number; Bede's formula can be cast in modern notation as:

$$I = (Y + 3) \text{ MOD } 15$$

if $I = 0$ then $I = 15$

Or, in Excel compact form:

$$= \text{IF} (+\text{MOD} (\text{Bn}+3, 15) = 0, 15, +\text{MOD} (\text{Bn}+3, 15))$$

where Bn is the cell holding the year.

Computation of the Lunar Epect

The Epects in the 19-year lunar cycle specifically stand for the age of the Moon on the 11th day prior to the Calends of April (22 March), since this is the beginning of the Paschal period (marked by the occurrence of the spring equinox). *A Lunar Epect 0 means that the Paschal lunar month (new Moon) starts immediately after the spring equinox for that particular year.*

If the Lunar Epect is less than 16, Easter will occur in the present lunation (i.e.: the lunar month that started prior, or immediately after, the spring equinox; in fact, if the Lunar Epect is 15 that means that XIII Moon occurs exactly at the spring equinox, and therefore Easter will fall as the first Sunday following that date. If not, Easter will occur during the next lunation. In fact, if the epect is 16, the full Moon occurs before the spring equinox, and we have to wait the next lunar month to celebrate Easter; in the words of Bede:

¹ This is an indication of the year of the writing of the tables by Bede.

² Dionysius Exiguus, *Argumenta Titolorum paschalium*.

³ Ref. [R2], 49, page 130.

This is because the fullness of the Paschal Moon ought not to precede the equinox, but rather should follow it, as was ordained in the beginning of Creation when the Sun first rose at the beginning of the day, holding to the spring equinox, and the Moon therefore rose at the beginning of the night, occupying the sector of the autumn equinox.

Therefore, the Easter cycle starts with Lunar Epact = 0 and a new cycle repeats after 19 years when a new Epact = 0 occurs on March 22.

According to Bede, the Lunar Epact can be computed very easily following his instructions:

If you want to know what the epacts are for any given year, take the number of years of the Lord, for example in the present eighth indiction, 725. Divide by 19. 19 times 30 is 570 and 19 times 8 is 152, with 3 left over. Multiply these by 11, which makes 33. Subtract 30 and the remainder is 3. The epact, that is, the lunar increment, is 3 [...]⁴.

Therefore, in modern terms, let Y be the year and E the Lunar Epact number; Bede's formula can be cast in modern notation as:

$$E = ((Y \text{ MOD } 19) * 11) \text{ MOD } 30$$

Or, in Excel compact form:

$$+\text{MOD}(\text{MOD}(\text{Bn}, 19) * 11, 30)$$

where Bn is the cell holding the year.

Age of the Moon of the first day of each month (lunar regulars)

The Lunar Epact provides a convenient mean to compute the age of the Moon on the first day (calends) of each month. In the words of Bede:

In the first year of the 19-year cycle, in which the epact is zero, the Moon on the kalends of January is 9 days old; on the first of February, 10; on the first of March, 9; on the first of April, 10; on the first of May, 11; on the first of June, 12; on the first of July, 13; on the first of August, 14; on the first of September, 16; on the first of October, 16; on the first of November, 18; on the first of December, 18. Take these numbers as the «regulars» of each month. By adding the annual epacts to them, you will discover without error what the age of the Moon is on any given kalends⁵.

⁴ Ref. [R2], 50, page 135.

⁵ Ref. [R2], 20, page 64.

If you wish to know the age of the Moon for the kalends of January in the second year of the decennovennal cycle, take the regular [of January] - 9 - and add the epact - 11 and that makes 20: it is the twentieth Moon. If you want to know what Moon it is on the kalends of June in the third year, take the regular 12, add the epact for that year - 22 - and that makes 34. Subtract 30 and 4 remain; on the kalends in question, the Moon is four days old.

[...]

For when the age of the Moon on the kalends is known, it will easily be seen what its age is on the other days of any month by reciting on one's fingers that month and its concurrents. However, there are three years in the 19-year cycle when this formula cannot preserve the stability of its course, namely the eighth, the eleventh and the nineteenth. The cause of this discrepancy is the insertion, distributed throughout the year in various ways, of the embolismic [month]. Now in the eighth year, the Moon on the kalends of May, according to the logic of this formula, is calculated as being in its twenty-eighth day, but because of the embolism inserted into the month of March, it is actually in its twenty-seventh. Again, according to the formula the Moon ought to be in its thirtieth day on the kalends of July, but because of the addition of the day which the superfluity of the embolism introduced, it is the twenty-ninth. Again in the eleventh year, because the Moon of the embolismic [month] is kindled on the day before the nones of December [4 December], it makes the Moon on the kalends of March to be in its twenty-eighth day, while the logic of the formula teaches that the Moon then is the twenty-ninth. Again in the nineteenth year, because the Moon of the embolismic [month] begins on the 3rd nones of March [5 March], it dictates that the Moon on the kalends of May be calculated as in its twenty-eighth day, when according to the calculation of the formula it is tallied as the twenty-ninth.

Moreover, in this [nineteenth] year the computation of the «leap of the Moon», of which we shall say more later vitiates the reliability of this formula. But if you start [to use] this formula at the month of September, after the manner of the Egyptians, whose year begins at that point, it is necessary that the Moon of July in that year have twenty-nine days and never more, one day having been removed because of the «leap of the Moon». In consequence, the Moon of the kalends of August, calculated as the second according to the rule of the formula, will be assigned as the third. But if, following what we taught above, you prefer to begin the formula in January, according to the same sequence the seventh day of the Moon will fall on the kalends of December, which one would think ought to be the sixth according to the formula. This is because the Moon of the month of November loses a day and is considered complete with only twenty-nine [days] instead of the usual thirty. In truth, all this is easier to teach by oral explanation than in writing. However, do not overlook the fact that some people begin this

formula from September, giving the regular 5 to September, 5 to October, 7 to November, 7 to December, and for the rest, as we give it above. Because of the authority of the Egyptians, they act in a thoroughly reasonable manner so as to imitate, in the calculation of the beginning of the year, those from whom the art of calculation took its origin. But to others it seems much more appropriate and efficient that all calculation, insofar as logical necessity presents no obstacle, should start from the beginning of their year, and continue onwards to the end of the year in a fixed and inviolable course: [this is the case] even among the Latins⁶.

A simpler possibility to just compute the age of the Moon at the beginning of the year is based on the fact that March 22 is the 82nd day of the year for a common year (the 83rd for a leap year). To obtain the age of the Moon on January 1st, we should start from March 21 (day 81, age of the moon is 29 for the first year of the 19-year cycle) and subtract 30, 29 and 30, the lengths of three successive lunar months (remember that the age of the Moon ranges from 0 to 29, not from 1 to 30!). This will bring the beginning of the last full lunar month in the previous year on the day of the year -8 (December 24). Therefore the age of the Moon on January 1st will be: $-(-8) + 1$. Therefore, the age L of the Moon on January first can be computed from the Lunar Epact E as given in Bede's tables as:

$$\begin{array}{rcl}
 L & = & -(81 - 89) + 1 + E \\
 | & | & | \\
 | & | & | \quad \text{Age of moon on March 22} \\
 | & | & | \quad \text{(Lunar Epact)} \\
 | & | & | \quad 3 \text{ lunar months} \\
 | & | & | \quad \text{March 21} \\
 | & | & | \quad \text{(day of year)} \\
 & & \text{Age of Moon on January 1}^{\text{st}}
 \end{array}$$

Bede itself reports an identical formula to compute the age of the Moon for any day:

22. A FORMULA FOR ANY MOON OR WEEKDAY

There is an old formula devised for finding the Moon or the weekday not only for the kalends, but for any day between kalends. It is somewhat more difficult to learn, but it was passed down to us by the authority of our elders, and so ought to be handed on conscientiously to our juniors. If you wish to know how old the Moon is on this or that day, count the

⁶ Ref. [R2], 20, page 66.

days from the beginning of January up to the day you want⁷, and when you know this, add in the age of the Moon on the kalends of January. Divide the total by 59, and if more than 30 remain, subtract 30. What is left over is the day of the Moon you are seeking. Again, if you wish to know what the weekday is on such and such a day, calculate the days from the beginning of January up to the day in question, and when you have found out what [the total] is, add the weekday on which the kalends of January fell. If it is a leap year, remember also to add the leap-year day after it has passed. Divide the total by seven and the remainder will show you what day of the week it is, in every case⁸.

Clearly, for Bede or anyone using the Roman calendar, matters were more complex due to the intrinsic complexity (for us) of the calendar construction:

This formula only works without difficulty if you are accustomed to reciting by heart the number of each of the months by kalends, nones and ides:

January: 1 on the kalends, 5 on the nones, 13 on the ides;
 February: 32 on the kalends, 36 on the nones, 44 on the ides;
 March: 60 on the kalends, 66 on the nones, 74 on the ides;
 April: 91 on the kalends, 95 on the nones, 103 on the ides;
 May: 121 on the kalends, 127 on the nones, 135 on the ides;
 June: 152 on the kalends, 156 on the nones, 164 on the ides;

 July: 182 on the kalends, 188 on the nones, 196 on the ides;
 August: 213 on the kalends, 217 on the nones, 225 on the ides;
 September: 244 on the kalends, 248 on the nones, 256 on the ides;
 October: 274 on the kalends, 280 on the nones, 288 on the ides;
 November: 305 on the kalends, 309 on the nones, 317 on the ides;
 December: 335 on the kalends, 339 on the nones, 347 on the ides.

So for example, if you wish to know what the age of the Moon is on the kalends of May in a year in which the Moon is nine days old on the kalends of January, say «May: 121 on the kalends». Subtract the [day of the] kalends, and 120 remains; add 9, and that makes 129. Divide by 59: 59 times 2 is 118. Subtract 118 and 11 remain. The Moon is 11 days old on the kalends of May. If you want to know how old the Moon is on the 15th kalends of June [May 18], say «June: 152 on the kalends». Subtract the fifteen kalends of June and 137 remain. Add 9, which makes 146. Divide by 59: 59 times 2 is 118. Subtract 118 and 28 remain. The Moon

⁷ This is the day of the year (DOY).

⁸ Ref. [R2], 22, page 69.

on the 15th kalends of June is 28 days old. If you want to know what the Moon is on the 7th ides of December [December 7], say «December: 347 on the ides». Subtract the seven ides, and 340 remain. Add 9, and it makes 349. Divide by 59: 59 times 5 is 295. Subtract 295 and 54 remain. Subtract 30, and 24 remain. On the day in question, it is the 24th [day of the] Moon.

In using this formula, it is helpful if the calculator commits the products of the fifty-nine-times table to memory:

59 times 6 is 354
 59 times 5 is 295
 59 times 4 is 236
 59 times 3 is 177
 59 times 2 is 118
 59 times 1 is 59

By the same procedure, you find the weekday for any date you wish by adding the [week]day of the kalends of January. For example, if you want to know what the weekday will be on the 8th kalends of October [September 24] in a year in which the kalends of January is celebrated on the fifth day of the week [Thursday], say «October: 274 on the kalends». Subtract the eight [kalends of October] and 266 remain. Add the fifth weekday on which the kalends of January fell, and that makes 271. Divide by 7: 7 times 30 is 210, 7 times 8 is 56; 5 are left over. It is the fifth day of the week on the 8th kalends of October⁹.

Concurrents (or Solar Epacts)

The fourth column of the Bede's table reports the concurrents (or Solar Epacts); the concurrent (a number from 1 to 7) shows which day of the week follows on a particular date (Sunday = 1; ... Saturday = 7). Bede explains why they repeat at the completion of the 28 years solar cycle:

53. SOLAR EPACTS

In the fourth column [*tramite*] of the 19-year cycle the solar epacts are designated, that is, the concurrent days of the week, which for three years always increase by the addition of one, but during leap year by the addition of two, up to the number seven. Their cycle runs for four times seven, or 28 years, because assuredly it cannot be completed until the leap-year day, which recurs in the fourth year, has fallen on every day of the week, that

⁹ Ref. [R2], 22, page 70.

is, Sunday, Friday, Wednesday, Monday, Saturday, Thursday, Tuesday; it runs through them in this order.

In the table, Bede lists the concurrent for the 9th day prior to the Kalends of April, which is 24 March; this, as Bede further explains, is because the 24 March is conveniently located at the beginning of the Paschal period, and therefore allows an easy search for the Easter Sunday:

Although every day of the year has its concurrents, those concurrents which are particularly attached to the [19-year] cycle are those which designate the weekday of the 9th kalends of April [24 March]. This is so that, being placed quite close to the beginning of the Paschal festivity, they may very readily display the day of the epacts, or what day of the week the fourteenth Moon [falls on], and thereby smooth the way to the discovery of Easter Sunday. For every year, the same day of the concurrents will fall on the 2nd kalends of April [31 March], the 7th ides of April [7 April], the 18th kalends of May [14 April] and the 11th kalends of May [21 April]: it is helpful to the computist to memorize these.

Then, Bede goes into a lengthy discussion on the repetitions of the concurrents with respect to the occurrence of the leap year in the cycle:

The course of their cycle is such that whatever the concurrents are in leap year, they are the same five years earlier and six years later. Whatever they are in the first year after the leap year, they will be the same as those which occurred eleven years before, and those which will recur in six years. Those for the second year after the leap year are the same as those which occurred six years previously, and which will recur after eleven years. Those in the third year after leap year are the same as those which took place six years before, and which will revert after five years. And the regular pattern of this division applies to all the days of the revolving year.

The important part comes at the end, and this is the basics of the 532-year cycle that escaped the attention of Victorius of Aquitaine, the first proponent of the cycle:

Take careful note of the fact that because of this solar cycle, which runs for 28 years, it is necessary that 28 19-year cycles be completed before the identical sequence for the observation of Easter is repeated in all respects, so that every year of this [solar] cycle becomes the first year of a 19-year cycle, and similarly, that each year of the 19-year cycle follows as the first

of this [solar cycle]. Thus the entire series of the Easter observance will be finished in no less than 532 years¹⁰.

Bede then proposes a formula to identify the leap years and to compute the concurrents; this is a step-by-step procedure to the construction of his table:

54. FORMULA FOR FINDING THE NUMBER OF THE SOLAR EPACTS, AND WHEN LEAP YEAR WILL FALL

Since the sequence of the [solar] epacts, that is, of the solar increment, coincides and is closely connected with the leap year, learn by means of this formula what is the state of both simultaneously.

If you want to know when the leap year will be, take the year of the Lord [725], divide it by 4, and if there is no remainder, it is leap year, if there is a remainder of], 2, or 3, it is 1, 2 or 3 years away from leap year. For instance, $4 \times 100 = 400$, $4 \times 80 = 320$, $4 \times 1 = 4$, with 1 left over, because it is the first year after the leap year.

If you wish to know the solar increment, that is, the concurrent days of the week, take the number of years from the Lord's Incarnation, for instance 725 (which is the 8th indiction), and add to this one-fourth of these years, that is, at present, 181, which together [with 725] makes 906. Add four to this, which makes 910. Divide by 7: $7 \times 100 = 700$, $7 \times 30 = 210$, with no remainder. Therefore the solar epact or concurrent days of the week are 7¹¹.

Bede follows these instructions with a method to compute the cycle of both Epacts using the fingers. While this may be an interesting topic on a medieval device for mathematical computations, I will skip for the moment being this method and will return to the construction of the Bede's table following the indications that Bede has given so far.

Therefore, in modern notation, the concurrent C for the year Y is computed as

$$C = [(Y + \text{Int}(0.25 \cdot Y) + 4) \text{ MOD } 7]$$

$$\text{If } C = 0 \text{ then } C = 7$$

Or, in Excel compact form:

¹⁰Ref. [R2], 53, page 136.

¹¹ Ref. [R2], 54, page 137.

$$\text{IF } (+\text{MOD}((\text{Bn} + \text{INT}(\text{Bn}/4)) + 4), 7) = 0, 7, +\text{MOD}((\text{Bn} + \text{INT}(\text{Bn}/4)) + 4), 7))$$

where Bn is the cell holding the year.

The Lunar Cycle

Probably Bede reports the lunar cycle in the 5th column of his table only for historical reasons (possibly it was related to other computistic practices dating back to the introduction of the table of Victorius of Aquitaine) since it is of no immediate use in the computation of Easter. In our case, as previously remarked, the Ravenna table is instead ordered based on this lunar cycle, possibly an indication of the historical moment in which it was drafted.

56. THE LUNAR CYCLE

The lunar cycle is contained in the fifth column [*regione*] of the 19-year cycle. It begins in the fourth year of that cycle, and ends in the third, and is linked to the month of January, and is Roman in origin¹².

Here, the commentator of the text of Bede in ref. [R2] tries to explain the Bede's words related to the origin of the lunar cycle:

The lunar cycle in column 5 must have been something of a puzzle to Bede, as it plays no role at all in the computation of Easter. It replicates the structure of the 19-year cycle, but begins in year 3 of the 19-year cycle, when the Moon is new on 1 January. Because of this 1 January epact, Bede took a guess that it was a Roman lunar cycle. This is not the case, but its true origin remains obscure. It arrived in the West with the ps.-Cyrillan Paschal table, and it was obviously meant to serve as a concordance to some other form of reckoning. Based on his guess, Bede therefore created a table patterned after the one Dionysius made for the 19-year cycle. The lunar cycle does have one use, however; it makes it easy to locate the age of the Moon on 1 January (ch. 57)¹³.

In my opinion, the origin of the lunar cycle is related to the attempt that Victorius of Aquitaine did to relate the Roman to the Alexandrian computus. Maybe Bede intended this when he refers to the Romans: not the ancient

¹² Ref. [R2], 56, page 139.

¹³ Ref. [R2], commentary to chapter 56, page 346.

Romans, but a more modern attempt (dated two centuries before Bede) to resolve the long dispute between Alexandria and Rome on the Paschal computus.

Moreover, it is true that on the year 3 of the 19-year Paschal cycle the Moon is new on 1 January, but this is a very strange notation indeed for the beginning of a cycle. From the Bede's table and from the Ravenna calendar we know that the year 1 of the lunar cycle corresponds to the 4th year of the 19-year cycle. This is clear from the Ravenna text:

$$\overline{LV} \cdot \overline{PRIMVS} \cdot \overline{AN} \cdot \overline{IIII} \overline{L} \cdot \overline{XIIII} \cdot \overline{IIII} \overline{NO} \overline{AP} \\ \overline{PA} \cdot \overline{VI} \cdot \overline{ID} \cdot \overline{AP} \cdot \overline{LV} \cdot \overline{XX}$$

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and also from the Bede's tables (see Figure 2 above).

A puzzling discrepancy on the beginning of the Lunar Cycle and the Age of the Moon on the Kalends of January

However, here I have a discrepancy of which I have not found solution myself; apparently Bede insists on the fact that the first year of the lunar cycle starts with the Moon of January:

For just as every year of the 19-year cycle begins and ends with the Paschal [lunar] month because of the observation [prescribed in] the law of the Jews, so likewise this [lunar year], as instituted by the Romans, begins with the Moon of the month of January and ends there¹⁴.

This concept will be reinforced later on, when Bede lists the beginning and the end of each year in the lunar cycle.

In lunar year 1 (19-year cycle 4) running from the kalends of January [1 January] to the 13th kalends of January [20 December], there are 354 days, because it is common¹⁵.

¹⁴ Ref. [R2], 56, page 139.

¹⁵ Ref. [R2], commentary to chapter 56, page 346.

Since for the beginning of the lunar month I can safely assume the day of the appearance in the sky of the first crescent of the new Moon, this will be the day following the new Moon, and the age of the Moon on this day will be 1.

This is not the case for the year listed as first year (1) of the lunar cycle in the Bede's tables, since from the Lunar Epact on March 22 (that is 3) I can easily reconstruct the age of the Moon on January 1st, and that is 12 (see Table IV below).

Instead, for the third cycle of the Paschal period¹⁶ the lunar month starts exactly on the Calends of January (1 January) as can be seen by inspection of Table V. But this is the last year of the lunar cycle and therefore ends on December 31st (second day before the Calends of January), which is not consistent with the duration of the lunar year, as given in the detailed structure below, where this year is made to start on the Ides of December (13 December) and ends on December 31st (384 days since it is embolismic).

The Bede's table is also consistent with the relationships given in ch. 20 of Bede's *De Temporum Ratione*:

20. WHAT THE AGE OF THE MOON IS ON ANY GIVEN FIRST DAY OF THE MONTH

In the first year of the 19-year cycle, in which the epact¹⁷ is zero, the Moon on the kalends of January is 9 days old; on the first of February, 10; on the first of March, 9; on the first of April, 10; on the first of May, 11; on the first of June, 12; on the first of July, 13; on the first of August, 14; on the first of September, 16; on the first of October, 16; on the first of November, 18; on the first of December, 18. Take these numbers as the «regulars» of each month. By adding the annual epacts to them, you will discover without error what the age of the Moon is on any given kalends.

If you wish to know the age of the Moon for the kalends of January in the second year of the decennovennal cycle, take the regular [of January] - 9 - and add the epact and that makes 20: it is the twentieth Moon. If you want to know what Moon it is on the kalends of June in the third year, take the regular 12, add the epact for that year - 22 - and that makes 34. Subtract and 4 remain; on the kalends in question, the Moon is four days old¹⁸.

¹⁶ See, for instance, the year 534 in Figure 2.

¹⁷ The age of the Moon on March 22 according the Bede's tables.

¹⁸ Ref. [R2], 20, page 64.

Age of the Moon (AoM) through March 22 for a common year					
Lunar Epact = 3 on March 22			= Beginning of Lunar Month		
January		February		March	
Day	AoM	Day	AoM	Day	AoM
1	12	1	13	1	12
2	13	2	14	2	13
3	14	3	15	3	14
4	15	4	16	4	15
5	16	5	17	5	16
6	17	6	18	6	17
7	18	7	19	7	18
8	19	8	20	8	19
9	20	9	21	9	20
10	21	10	22	10	21
11	22	11	23	11	22
12	23	12	24	12	23
13	24	13	25	13	24
14	25	14	26	14	25
15	26	15	27	15	26
16	27	16	28	16	27
17	28	17	0	17	28
18	29	18	1	18	29
19	0	19	2	19	0
20	1	20	3	20	1
21	2	21	4	21	2
22	3	22	5	22	3
23	4	23	6	23	
24	5	24	7	24	
25	6	25	8	25	
26	7	26	9	26	
27	8	27	10	27	
28	9	28	11	28	
29	10				
30	11				
31	12				

Table IV. Age of the Moon (AoM) through March 22 (Lunar Epact = 3) for a Common Year.

Age of the Moon (AoM) through March 22 for a common year					
Lunar Epact = 22 on March 22			= Beginning of Lunar Month		
January		February		March	
Day	AoM	Day	AoM	Day	AoM
1	1	1	2	1	1
2	2	2	3	2	2
3	3	3	4	3	3
4	4	4	5	4	4
5	5	5	6	5	5
6	6	6	7	6	6
7	7	7	8	7	7
8	8	8	9	8	8
9	9	9	10	9	9
10	10	10	11	10	10
11	11	11	12	11	11
12	12	12	13	12	12
13	13	13	14	13	13
14	14	14	15	14	14
15	15	15	16	15	15
16	16	16	17	16	16
17	17	17	18	17	17
18	18	18	19	18	18
19	19	19	20	19	19
20	20	20	21	20	20
21	21	21	22	21	21
22	22	22	23	22	22
23	23	23	24	23	
24	24	24	25	24	
25	25	25	26	25	
26	26	26	27	26	
27	27	27	28	27	
28	28	28	0	28	
29	29				
30	0				
31	1				

Table V. Age of the Moon (AoM) through March 22 (Lunar Epact = 22) for a Common Year.

Therefore, it remains to be explained why the first (lunar) year of the lunar cycle is made to run from the Kalends of January (January 1st), when the Moon is clearly 9 days old instead then 1, as it would be if the beginning of the lunar month occurs on January 1st (see detailed structure below).

The situation is summarized in the following table:

Paschal cycle	Lunar cycle	Age of Moon on 1 January	Epact (22 March)
1	17	9	0
2	18	20	11
3	19	1	22
4	1	12	3
5	2	23	14
6	3	4	25
7	4	15	6
8	5	26	17

Table VI. Correspondence between the Paschal cycle, lunar cycle, age of the Moon on 1 January and Epact on March 22.

Detailed structure of the lunar cycle

Bede, then, takes care to explain the complete equivalence of the two cycles (Ch. 56 again):

What applies to the former [i.e. to the 19-year cycle] also applies to this one: the first and second years are common, the third is embolismic; the fourth and fifth are common, the sixth is embolismic; the seventh is common, the eighth is embolismic. Also the *hendecas* of the lunar cycle, just like that of the 19-year cycle, has seven common years and four embolismic ones. The common years have 12 lunar months and 354 days, but the embolismic ones have 13 lunar months and 384 days, minus one from the 17th year of this cycle, which is the first year of the 19-year cycle, from which one day is subtracted because of the «leap of the Moon». In order to make this plainer, let us look at the course of each year in order, and do for January what Dionysius has done for the Paschal month¹⁹.

Then, Bede reports the detailed structure of the lunar cycle, giving the start and end dates and the length of the year (common or embolismic):

¹⁹ Ref. [R2], 56, page 139.

In lunar year 1 (19-year cycle 4) running from the kalends of January [1 January] to the 13th kalends of January [20 December], there are 354 days, because it is common.

In lunar year 2 (19-year cycle 5) running from 12th kalends of January [21 December] to the 5th ides of December [9 December], there are 354 days, because it is common.

In lunar year 3 (19-year cycle 6) running from the 4th ides of December [10 December] to the 5th kalends of January [28 December], there are 384 days, because it is embolismic.

In lunar year 4 (19-year cycle 7) running from the 4th kalends of January [29 December] to the 16th kalends of January [17 December], there are 354 days, because it is common.

In lunar year 5 (19-year cycle 8) running from the 15th kalends of January [18 December] to the 8th ides of December [6 December], there are 354 days, because it is common.

In lunar year 6 (19-year cycle 9) running from the 7th ides of December [7 December] to the 8th kalends of January [25 December], there are 384 days, because it is embolismic.

In lunar year 7 (19-year cycle 10) running from the 7th kalends of January [26 December] to the 19th kalends of January [14 December], there are 354 days, because it is common.

In lunar year 8 (19-year cycle 11) running from the 18th kalends of January [15 December] to the 4th nones of January [2 January], there are 384 days, because it is embolismic.

In lunar year 9 (19-year cycle 12) running from the 3rd nones of January [3 January] to the 11th kalends of January [22 December], there are 354 days, because it is common.

In lunar year 10 (19-year cycle 13) running from the 10th kalends of January [23 December] to the 3rd ides of December [11 December], there are 354 days, because it is common.

In lunar year 11 (19-year cycle 14) running from the 2nd ides of December [12 December] to the 3rd kalends of January [30 December], there are 384 days, because it is embolismic.

In lunar year 12 (19-year cycle 15) running from the 2nd kalends of January [31 December] to the 14th kalends of January [19 December], there are 354 days, because it is common.

In lunar year 13 (19-year cycle 16) running from the 13th kalends of January

[20 December] to the 6th ides of December [8 December], there are 354 days, because it is common.

In lunar year 14 (19-year cycle 17) running from the 5th ides of December [9 December] to the 6th kalends of January [27 December], there are 384 days, because it is embolismic.

In lunar year 15 (19-year cycle 18) running from the 5th kalends of January [28 December] to the 17th kalends of January [16 December], there are 354 days, because it is common.

In lunar year 16 (19-year cycle 19) running from the 16th kalends of January [17 December] up to the nones of December [5 December], there are 354 days, because it is common.

In lunar year 17 (19-year cycle 1) running from the nones of December [5 December] up to the 10th kalends of January [23 December], there are 384 days, because it is embolismic.

In lunar year 18 (19-year cycle 2) running from the 9th kalends of January [24 December] up to the 2nd ides of December [12 December], there are 354 days, because it is common.

In lunar year 19 (19-year cycle 3) running from the ides of December [13 December] up to the 2nd kalends of January [31 December], there are 384 days, because it is embolismic²⁰.

Bede remarks that, because of the shift of 4 years between the Paschal cycle (Dionysius Exiguus) and the Lunar cycle (referred to by Victorius of Aquitaine in ordering his tables) the *saltus lunae*, that occurs at the end of the 19th year of the Paschal cycle, now occurs at the end of the 16th year of the lunar cycle, and therefore the 17th year of the latter begins on the same day in which the 16th year ended (the Nones of December, i.e.: 5 December):

The computation of the 17th lunar year begins on the same day on which the previous year ended, and not on the day following, as do the others, for this reason: so that one day will not seem to be lacking in that year, because of the so-called «leap» of the Moon. Dionysius, surveying the 19-year cycle in like fashion, taught the same thing: he brings the final year to a close on the same day on which the first year is to begin²¹.

²⁰ Ref. [R2], 56, page 139.

²¹ Ref. [R2], 56, page 141.

This is consistent with the inferred reciprocal position of the two cycles and makes even more puzzling to me the discrepancy noted above.

Computation of the age of the Moon on 1 January

Then Bede follows with a formula useful to compute the age of the Moon on 1 January, the only (possibly) reasonable use of the lunar cycle according to the commentator of Bede's work:

57. FORMULA BASED ON THE LUNAR CYCLE FOR FINDING THE AGE OF THE MOON ON 1 JANUARY

Anyone who wants to can make a formula from the lunar cycle in order to find the age of the Moon on the kalends of January. Take any year of the lunar cycle, for instance, 5. Multiply by 11, and that makes 55. Always add the regular [for January], and that makes 56. Divide by 30, and the remainder is 26. In the 5th year of the lunar cycle, the Moon is 26 days old on the kalends of January. Again, take 8. Multiply by 11, and it makes 88. Add one regular, and divide by 30, and 29 will be left over. In the 8th year of the lunar cycle, the Moon will be 29 days old on the above-mentioned kalends. Only remember to add 2 regulars in the 17th, 18th and 19th years of this cycle, not 1 as in other years, and you will find the Moon on the kalends without any mistake²².

Previously (Ch. 20, see above) Bede had defined the regulars of the month as the number giving the age of the Moon on 1st January. Now the regulars seem to be defined as the excess of days in the solar month with respect to the days in the corresponding lunar month (1 for January since we have 21 days against 30 days of the first lunar month). This explains also the two regulars for the years 17 to 19 of the lunar cycle to account for the *saltus lunae* which was placed by Dionysius Exiguus at the end of the Paschal cycle and ends up to occur at the end of the 16th year in the computus of Victor.

But, again, this formula does not provide an age of the Moon of 1 in the first year of the cycle, instead the computations yield a value of 9 (see Table VI above). The formula, in modern notation, can be cast in the following equation (this has not been implemented in the spreadsheet):

$$A_{1-Jan} = (L \cdot 11) + 1 \text{ MOD } 30$$

where A_{1-Jan} is the age of the Moon on 1 January and L is the year of the lunar cycle.

²² Ref. [R2], 57, page 141.

Computation of the relationship between year and Paschal and Lunar cycles

58. A FORMULA TO FIND WHAT YEAR OF THE LUNAR CYCLE OR OF THE NINETEEN-YEAR CYCLE IT IS

If you wish to know the year of the lunar cycle, take the year of our Lord, for instance 725, and always subtract two: there remain 723. Divide these by 19, and there is a remainder of 1; it is the first year of the cycle. But whenever there is no remainder, it is the 19th year. And because the 19-year cycle keeps the same course as the lunar cycle, but a bit behind it, if you wish to know what year of this cycle it is, take the year of the Lord, for instance 725, and always add 1; this makes 726. Divide by 19, and there is a remainder of 4. It is the fourth year of the 19-year cycle. If there is nothing left over, it is the last year²³.

The formulas are self-explanatory. If Y is the Julian year, L is the year of the Lunar cycle and P is the year of the Paschal cycle (the 19-year cycle in Bede's terms), then:

$$\begin{array}{ll} L = (Y - 2) \text{ MOD } 19 & \text{if } L = 0 \text{ then } L = 19 \\ P = (Y + 1) \text{ MOD } 19 & \text{if } L = 0 \text{ then } P = 19 \end{array}$$

Computation of the Fourteenth Moon of Easter

Now we come to the heart of Bede's computus; the computation of the XIII day of the lunar month following the spring equinox. It was also the main issue of the Paschal dispute, since it sets the limits for the occurrence of Easter. Bede has already computed the epact, i.e. the age of the Moon on March 22, and therefore it is trivial to derive the following XIII day of the lunar month:

59. THE FOURTEENTH MOON OF EASTER

The sixth section [*locus*] of the aforementioned cycle contains the fourteenth Moons of the first month, which indicate without any ambiguity the day of Easter Sunday in every year; for the Sunday which comes after the fourteenth Moon is the Paschal day of the Lord's Resurrection. This fourteenth Moon manifests its progress over the Earth at sundown on the equinox, that is, the 12th kalends of April [21 March] at the earliest, and at the latest 29 days later, that is, on the 14th kalends of May [18 April]. It is agreed that according to the time appointed by the Law [*legali tempo-*

²³ Ref. [R2], 58, page 142.

re] the course of the Paschal observance is contained within these limits throughout the nineteen years [of the cycle]. And even were it possible for this same fourteenth Moon to fall on Saturday every year, nothing would displace the time of our Paschal observance from its lawful [time]²⁴.

The *terminus a quo* is the spring equinox, and the last possible date is 29 days later (because April's lunar month is «hollow»). The computation is based on the epact (on 22 March) that has been computed previously:

60. A FORMULA FOR FINDING IT

The skillful computist ought to memorize the fourteenth Moons of the first month, just as he memorizes the annual lunar epacts. But if anyone wishes to find it by means of a formula, let him look at what the epacts are of the year he wishes to compute, and if they are 14 or 15, let him know that the fourteenth Moon will come on the 11th or 12th kalends of April [22 or 21 March]. For, as has often been mentioned, the 11th kalends of this month is the proper date of all the epacts. If the epacts are less [than 14], let him count upwards day by day until he reaches the number 14, and let him not doubt that he has there the fourteenth Moon of Easter. But if the epacts are more than 15, let him count upwards day by day up to 30, which is the end of this month. Then, beginning at the first Moon and arriving in sequence at the fourteenth, he will find the day duly ordained for the Paschal rites. Note also that if it is a common year, the fourteenth Moon will recur eleven days earlier than in the previous year, and if it is an embolismic year, nine days later. There is, however, one exception: the first year of the 19-year cycle, in which, because of the «leap of the Moon», it customarily precedes its course of the previous year by twelve days²⁵.

The reasoning is simple. If the epact on 22 March is 14 then the fourteenth Moon will just fall on 22 March. If the epact is 15, the fourteenth Moon will occur on March 21. But this is the *terminus a quo*.

Therefore, if the epact is less than 14 on 22 March, then the computist must only count a proper number of days forward from 22 March until it reaches 14, and that will be the day of the fourteenth Moon. But if the epact on 22 March is already greater than 15, this means that the full Moon has occurred prior to the spring equinox and we must wait for the next lunation. The situation is shown in the first two columns of Table VII.

In the Excel spreadsheet the day of the fourteenth Moon is simply calculated by using Table VII as a lookup table, where the pointer to the entry

²⁴ Ref. [R2], 59, page 142.

²⁵ Ref. [R2], 60, page 144.

Lunar epact	14th Moon	Elapsed days from March 24
0	5 April	12
1	4 April	11
2	3 April	10
3	2 April	9
4	1 April	8
5	31 March	7
6	30 March	6
7	29 March	5
8	28 March	4
9	27 March	3
10	26 March	2
11	25 March	1
12	24 March	0
13	23 March	-1
14	22 March	-2
15	21 March	-3
16	19 April	26
17	18 April	25
18	17 April	24
19	16 April	23
20	15 April	22
21	14 April	21
22	13 April	20
23	12 April	19
24	11 April	18
25	10 April	17
26	9 April	16
27	8 April	15
28	7 April	14
29	6 April	13

Table VII. Correspondence between lunar epact and day of 14th Moon.

is provided by the corresponding epact. As an example, if the lunar epact is zero (first entry in the Bede's table) the fourteenth Moon falls on April 5 (entry pointed by the lunar epact in Table VII). For the second entry (AD 533) the epact is 11 and the corresponding date for the fourteenth Moon in Table VII is March 25.

The Excel instruction for table look-up is the following:

`=+VLOOKUP(Dn,'Epact Correspondence'!$A$5:$B$34,2)`

or, in detail:

`=+VLOOKUP(Dn,'Epact Correspondence'!$A$5:$B$34,2)`

		Range	
	Table sheet		
Pointer		Data column	
to the table			

and D_n is the lunar epact E for the n -th row of the table.

Easter Sunday

The corresponding earliest possible day for Easter is 23 March and the last is 19 April. The computation of the date of Easter Sunday is based on the computed occurrence on the fourteenth Moon and the concurrent on March 24 (solar epact) that has already been computed. I have already outlined in Table VII the elapsed days from 24 March along with the lunar epacts and the possible dates for the fourteenth Moon.

Bede's 532 Years Paschal Table										
A.D.	A.D.	Indiction	Lunar epact	Concurrent	Lunar cycle	14th Moon	Easter	Moon on Easter day	Correspondence to Easter date	DoW on 14th Moon
-1	532	10	0	4	17	5 April	11 April	20	24.00	2.00
1	533	11	11	5	18	25 March	27 March	16	9.00	6.00
2	534	12	22	6	19	13 April	16 April	17	19.00	5.00
3	535	13	3	7	1	2 April	8 April	20	27.00	2.00
4	536	14	14	2	2	22 March	23 March	15	13.00	7.00

Figure 3. Example of Easter Day computation.

Knowing the concurrent on 24 March allows to relate the computation of the fourteenth Moon to find the Easter Sunday. The process will be better shown by using the Table VIII and consider for the moment being only the first, second and fourth column (disregard column 3). The first column shows the epact and the corresponding day of the Month. The fourth column shows the solar epact (concurrent) for that particular day.

If the epact is 0 (first entry in Bede's table for AD 532) we know that the fourteenth Moon occurs on 5 April which is the twelfth day following 24 March (Table VIII).

1. First, find the day of week (DoW) for the day of occurrence of the fourteenth Moon (last column in Figure 3). Given the epact we know the day of the fourteenth Moon and from the last column in Table VIII the number of days elapsed from 24 March are known. Add to this number the concurrent (day of the week on 24 March) and you get the day of the week DoW_{XIII} on the fourteenth Moon day, that must be reduced between and 7 by taking the remainder of the division by seven, or using the Modulo operator:

- $DoW_{XIII} <---- Easter_Day_Table (Epact) + Concurrent$
- $DoW_{XIII} = DoW_{XIII} \text{ MOD } 7$

$$c. \text{ if } DoW_{XIII} = 0 \text{ then } DoW_{XIII} = 7$$

which in Excel format can be written compactly as:

```
=IF(+MOD(VLOOKUP(D4,'Easter Day  
Correspondence'!$A$3:$D$32,4)+E4,7)  
= 0, 7, +MOD(VLOOKUP(D4,'Easter Day  
Correspondence'!$A$3:$D$32,4)+E4,7))
```

where D_n is the lunar epact E and E_n is concurrent the for the n -th row of the table.

2. Easter will occur on the day of the week = 1. Therefore, if the fourteenth Moon occurs on $DoWXIII$, Easter will occur $8 - DoWXIII$ days after (days of week run from 1 to 7 inclusive, 0 is not considered). Subtract²⁶ this number from the epact that was used as an index for the fourteenth day Moon. In this way, the resulting number J can be used to point to the date of Easter instead than to the date of the fourteen Moon in the same table that was used to compute the day of occurrence of the latter. If $J < 0$ then $J = J + 30$. This will be used as the pointer J to *Easter_Day_Correspondence* table that replicates the *Epact_Correspondence* table. Therefore, the index J is computed as:

$$J = E - 8 + DoW_{XIII} \qquad \text{if } J < 0 \text{ then } J = J + 30$$

or, in Excel format, as: $=+IF(D_n-8+L_n < 0, D_n-8+L_n+30, D_n-8+L_n)$ where D_n is the lunar epact E and L_n is DoW_{XIII} the for the n -th row of the table.

As an example, in the second entry of the table (Figure 3), $DoWXIII = 6$, therefore Easter will occur $8 - DoWXIII$ days after, i.e.: 2 days after. Subtract 2 from the epact (the epact was used as an index to point to the day of occurrence of the fourteenth Moon, therefore I am effectively displacing the pointer to the table of an integer number (of days) from the day of occurrence of the fourteenth Moon). The result is 9 ($11 - 2$) which is entered in the column labeled «Correspondence to Easter date» in Figure 3.

As a second example, consider the first entry of the table (Figure 3); $DoWXIII = 2$ (which is Monday), therefore Easter occurs $8 - 2 = 6$ days later. The Epact is 0 (this is the first year of the Paschal cycle) therefore

²⁶ I could have avoided this subtraction to derive the Easter date from the same table that was used to find the day of the fourteenth Moon, and instead I could have built a separate table, but it was easier to reuse the table of epacts that was already in place.

Epact	Day of month	Day of month, alternate, if epact > 15	Solar epact (concurrent) relative to March 24
0	5 April		12
1	4 April		11
2	3 April		10
3	2 April		9
4	1 April		8
5	31 March		7
6	30 March		6
7	29 March		5
8	28 March		4
9	27 March		3
10	26 March	25 April	2
11	25 March	24 April	1
12	24 March	23 April	0
13	23 March	22 April	-1
14	22 March	21 April	-2
15	21 March	20 April	-3
16	19 April	19 April	26
17	18 April	18 April	25
18	17 April	17 April	24
19	16 April	16 April	23
20	15 April	15 April	22
21	14 April	14 April	21
22	13 April	13 April	20
23	12 April	12 April	19
24	11 April	11 April	18
25	10 April	10 April	17
26	9 April	9 April	16
27	8 April	8 April	15
28	7 April	7 April	14
29	6 April	6 April	13

Table VIII. Easter day correspondence.

$J = -6$, or $J = 24$. In the *Epact_Correspondence* table, for $J = 24$ the date is April 11 (which is 6 days after April 5, the date of the fourteenth Moon).

Use the index J to find the date of Easter in the same table of the epacts, since it has already been shifted of the proper amount of days elapsed from the day of the fourteenth Moon because of the day of the week in which the latter occurs. However, as was mentioned before, if the date of the fourteenth Moon occurs prior of the spring equinox, we have to move the date of the fourteenth Moon (and the corresponding Easter date) to the

next lunation. This is the purpose of the second column in the *Easter Day Correspondence* table, that otherwise would have appeared identical to the *Epact_Correspondence* table. Therefore, if the epact $E > 15$ get the Easter day from the third column of the table, otherwise from the second. If K is the index of the column of the table where to get the data, we have:

$$\text{if } E > 15 \text{ then } K = 3 \text{ else } K = 2 \\ \text{Easter_Day} \leftarrow \text{Easter Day Correspondence_table}(J, K)$$

or in Excel format, where everything is placed in one instruction:

$$\begin{aligned} &= \text{VLOOKUP}(\text{IF}(\text{Dn}- \\ &8 + \text{Ln} < 0, \text{Dn} - 8 + \text{Ln} + 30, \text{Dn} - 8 + \text{Ln}), \\ &\text{'Easter Day Correspondence'!}\$A\$3:\$D\$32, \\ &\text{IF}(\text{Dn} > 15, 3, 2)) \end{aligned}$$

where D_n is the lunar epact E and L_n is DoW_{XIII} the for the n -th row of the table.

Computation of the age of the Moon at Easter

The index J that was used before to point to the date of Easter in the table of epacts represents a pointer shifted of the number of days between Easter and the fourteenth Moon. Therefore, since it is obvious that the age of the fourteenth Moon is 14, we have only to subtract J from E (lunar epact) and add 14 to get the age of the Easter Moon ($AoEM$):

$$AoEM = E - J + 14 \quad \text{if } AoEM < 0 \text{ then } AoEM = AoEM + 30$$

and, in Excel format:

$$= \text{IF}(\text{Dn} - \text{Kn} < 0, \text{Dn} - \text{Kn} + 30 + 14, \text{Dn} - \text{Kn} + 14)$$

where D_n is the lunar epact E for the n -th row and K_n is the index J .

Acknowledgments

The author wishes to thanks Mrs. Laura Obertino that first brought to my attention the inscribed slab of marble with the Paschal calendar currently preserved in the Archiebiscopal Museum in Ravenna, Italy. I am indebted to Dr. Philipp Nothaft for the long correspondence that led me to revise my understanding of Victorius of Aquitaine contribution to the Computus, and to Dr. Dan McCarthy, Dr. Paola Maroni and Prof. Ulrich Voigt for the correspondence that has helped to clarify many points. I am also particularly indebted to Dr. Mariagrazia Falcone for her patient efforts to polish and render acceptable the transliteration of the epigraphic text, originally attempted on my degraded knowledge of the Latin language... A particular acknowledgement I owe to Prof. Alessandro Roccati, for his friendship and constant encouragement, and without whom this publication would not have been possible. Finally, I would like to express my appreciation to Dr. Maria Filippi of the Publication Dept. of the Academy of Sciences of Turin for her professionalism, her patience and her dedication in the editing of this publication.

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(a.a. 2017-2018)

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di EDOARDO DETOMA

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Errata Corrige to "An Easter Date Calendar in Ravenna"

I am grateful to Mr. Karl-Heinz Lewin for providing interesting comments and for pointing the following errors, the responsibility of which is only mine:

Page	Errata	Correction / <i>additional comments</i>																																													
7	the Sunday after Nisan.	the Sunday after the 14 th of Nisan.																																													
8	... the Passion took place in reality on Nisan XV ² .	<i>This is related to the fact that the Last Supper cannot have been held on the evening of Pesach, since this was the day of the crucifixion. But it was not my intent to discuss this matter in the paper and it is outside my area of competence. I have read that many scholars are inclined to consider the Last Supper not as the Pesach seder, but I am reluctant to discuss these arguments since they are outside my field of knowledge...</i>																																													
13	28 years = 255500 days	28 years = 10227 days																																													
13	... the 112-year cycle of Hyppolitus, which was a double cycle ¹⁴ of octaëteris (8-year cycle), repeated four times (see ref. [R3]);	... the 112-year cycle of Hyppolitus, which was a double cycle¹⁴ of octaëteris (8-year cycle), repeated seven times (see ref. [R3]); <i>This is the Pedersen's table (see ref. [R3], page 38) for the 112 years cycle based on the octaëteris:</i> TABLE 2. <table><tr><th>Cycle</th><th>Year</th><th>AD</th><th>Moon</th><th>Weekday</th></tr><tr><td>I</td><td>1</td><td>222</td><td>April 13</td><td>Saturday</td></tr><tr><td>II</td><td>17</td><td>238</td><td>April 13</td><td>Friday</td></tr><tr><td>III</td><td>33</td><td>254</td><td>April 13</td><td>Thursday</td></tr><tr><td>IV</td><td>49</td><td>270</td><td>April 13</td><td>Wednesday</td></tr><tr><td>V</td><td>65</td><td>286</td><td>April 13</td><td>Tuesday</td></tr><tr><td>VI</td><td>81</td><td>302</td><td>April 13</td><td>Monday</td></tr><tr><td>VII</td><td>97</td><td>318</td><td>April 13</td><td>Sunday</td></tr><tr><td>[VIII]</td><td>113</td><td>334</td><td>April 13</td><td>Saturday]</td></tr></table>	Cycle	Year	AD	Moon	Weekday	I	1	222	April 13	Saturday	II	17	238	April 13	Friday	III	33	254	April 13	Thursday	IV	49	270	April 13	Wednesday	V	65	286	April 13	Tuesday	VI	81	302	April 13	Monday	VII	97	318	April 13	Sunday	[VIII]	113	334	April 13	Saturday]
Cycle	Year	AD	Moon	Weekday																																											
I	1	222	April 13	Saturday																																											
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14	<i>hendecas</i> emaining 11 years	<i>hendecas</i> remaining 11 years																																													
17	Footnote 26: ...was only know late	...was only known late																																													

Page	Errata	Correction / <i>additional comments</i>
18	The consequence was that the Easter dates according Victorius showed one day of difference in 13 of the 19 years of the cycle (years 7th to 19th).	The consequence was that the Easter dates according Victorius were affected by the one day of difference in 13 of the 19 years of the cycle (that is, in the years 7th to 19th). <i>The one day of difference was indeed in the cycles (Roman vs. Alexandrian), not in the Easter dates, as explained before. The reason is due to the decision by Victorius to insert the saltus lunae in the 6th year of the 19 years cycle used in Alexandria. See footnote 97 in Bede/Faith Wallis, "Preface", page li.</i> 97 Why Victorius did this may seem baffling, since his letter to Hilarius acknowledges that the insertion of the <i>saltus</i> at the end of nineteen years is preferable (<i>quod est verius</i>): Krusch, <i>Studien II</i>, 19.8. The reason was the epoch Victorius chose for his table. Victorius held that his Paschal cycle should follow nature by beginning with Creation. His epoch, though, was the <i>annus Passionis</i>, which he set at <i>annus mundi</i> 5229, following Eusebius' chronology. 5229 divided by 19 leaves 4 as a remainder, so <i>annus Passionis</i> 1 is year 4 of Victorius' cycle. In order to insert the <i>saltus</i> in year 19 of his cycle, Victorius had to place it at <i>annus Passionis</i> 16, and every 19th year following. But <i>annus Passionis</i> 16 was year 6 of the Alexandrian cycle: cf. Jones, <i>BOT</i> 65. This error is discussed by Bede in <i>The Reckoning of Time</i>, ch. 42. <i>See also Pedersen, page 49:</i> Since the first year of the cycle was placed as the fourth year of an Alexandrian 19 year period Victorius was forced to place a <i>saltus</i> (in year 19 of the Alexandrian cycle) in the 16th year of his own cycle, and then with intervals of 19 years. This meant that the Victorine <i>saltus</i> occurred in the sixth year of the 19 year cycle actually used in Alexandria, which referred to the era of Diocletian (A.D. 284) but not to the year of Creation. In consequence the Victorine and the Alexandrian Easter would differ by one day in 13 out of the 19 years of the Alexandrian cycle. Furthermore, Victorius was unable to keep his Easter date within the traditional limits of the Roman Church. Thus in the 37th year of his cycle he placed Easter day on April 22, in the 48th year on April 23, and so on in numerous other cases. He does not comment on this departure from Western tradition which was the obvious price to be paid for having an Easter Canon of such a long span of years. Accordingly it met with opposition and did not immediately supplant earlier Roman cycles or the new Cyrillan table which was preferred by many churches in the latter half of the fifth century, particularly in North Africa. <i>See also the years in which the discrepancy occurs are noted in Bede/Faith Wallis, "Preface", page li:</i> On every other ground, however, Victorius' table was riddled with problems. First, he placed his <i>saltus</i> in the 6th year of his (and the Alexandrian) cycle, which meant that his cycle was out of phase with the Alexandrian one for years 7–19.⁹⁷
21	Apparently, the sectors are ordered in the lunar cycle ³³	Apparently, the sectors are numbered in the lunar cycle ³³

Page	Errata	Correction / <i>additional comments</i>
52	from the Lunar Epact E as given in Bede's tables as: (the vertical bars do not hit their targets.)	The lines identifying the components of Bede's formula are not aligned with the elements in the formula itself due to misplacements when printing. The should have appeared as follows: $L = -(81 - 89) + 1 + E$ <pre> Age of moon on March 22 (Lunar Epact) 3 lunar months March 21 (day of year) Age of Moon on January 1st </pre>
52	Bede itself reports	Bede himself reports
53	December: 335 on the kalends, 339 the nones, 347 on the ides	December: 335 on the kalends, 339 on the nones, 347 on the ides
56	... if there is a remainder of], 2, or 3, ...	... if there is a remainder of 1, 2, or 3,...
58		so Bede confounded years 3 and 4 of the 19-year-cycle - year 3 starting with new Moon, year 4 starting the Lunar cycle. This is a possible explanation.... do you know if any other scholar has tackled this issue?
69	The corresponding earliest possible day for Easter is 23 March and the last is 19 April.	The corresponding earliest possible day for Easter is 22 March and the last is 25 April. <i>See Pedersen, page 53 and appendix 2, pp. 392 and ff., in Bede/Faith Wallis.</i>
69	The first column shows the epact and the corresponding day of the Month.	The first column shows the epact and the second shows the corresponding day of the Month.
69	...that must be reduced between and 7 by taking...	... that must be reduced between 1 and 7 by taking...
70	...where Dn is the lunar epact E and En is concurrent the for the n-th row of the table.	... where Dn is the lunar epact E and En is the concurrent for the n-th row of the table.

Additional remarks by Mr. Karl-Heinz Lewin:

Page	Text to which the comment applies	Remarks by Mr. Karl-Heinz Lewin
24	Only one error is found in the compilation of the table: in the ninth sector, third cycle, the age of the Moon is given as 17, while it should be 16 instead.	In Noris' chalcography (see ref. [C1]), there is a second error in sector 7 (LU CI) fifth cycle, where the age of the moon is given as 20 (LU XX), while it should be 21. On the marble table, the "I" is faintly visible. <i>My remark: I have used the photographs of the table, see page 31. In the photographs the "I" is visible. And in any case, it could be recovered since the information for each cycle is redundant.</i>

Page	Text to which the comment applies	Remarks by Mr. Karl-Heinz Lewin
19 and 57	The lunar cycle in column 5 must have been something of a puzzle to Bede, as it plays no role at all in the computation of Easter. It replicates the structure of the 19-year cycle, but begins in year 3 of the 19-year cycle, when the Moon is new on 1 January. Because of this 1 January epact, Bede took a guess that it was a Roman lunar cycle. This is not the case, but its true origin remains obscure (from ref. [R2.], page 346).	Whereas the Moon is new on 1 January in year 3, which is the last year of the lunar cycle, and the lunar cycle starts in year 4, cf. pp. 58+
58	For just as every year of the 19-year cycle begins and ends with the Paschal [lunar] month because of the observation [prescribed in] the law of the Jews, so likewise this [lunar year], as instituted by the Romans, begins with the Moon of the month of January and ends there. (Ref. [R2], 56, page 139)	So, Bede confounded years 3 and 4 of the 19-year-cycle - year 3 starting with new Moon, year 4 starting the Lunar cycle. <i>My remark: this is a possible explanation.... see also previous comment</i>
62	The common years have 12 lunar months and 354 days, but the embolismic ones have 13 lunar months and 384 days, minus one from the 17th year of this cycle, which is the first year of the 19-year cycle, from which one day is subtracted because of the «leap of the Moon». (from ref. [R2], 56, page 139.)	Bede's mistake: one day is cancelled from the 16th year of the Lunar cycle which is the 19th year of the 19-year-cycle.
67	The <i>terminus a quo</i> is the spring equinox, and the last possible date is 29 days later (because April's lunar month is «hollow»).	The length of April's lunar month is irrelevant here, what counts is the maximum remaining days of March's lunar month, which are $30-15=15$, plus 14 giving 29. <i>My remark: I have followed the suggestion in Bede/Faith Wallis, page 346, in the commentary to chapt. 59. This also matches with my computations in Excel.</i>